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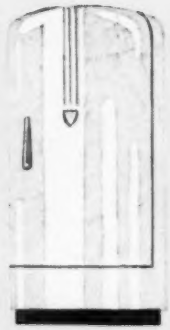

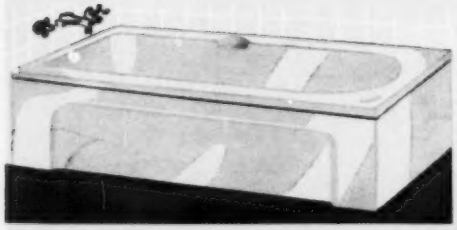

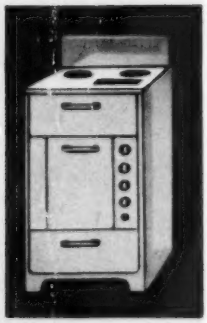

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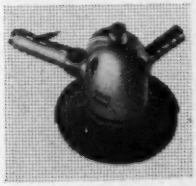
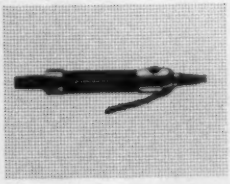
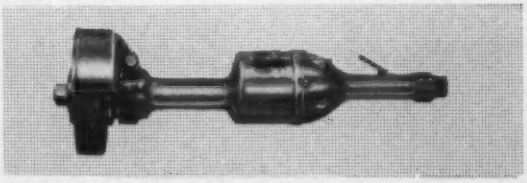


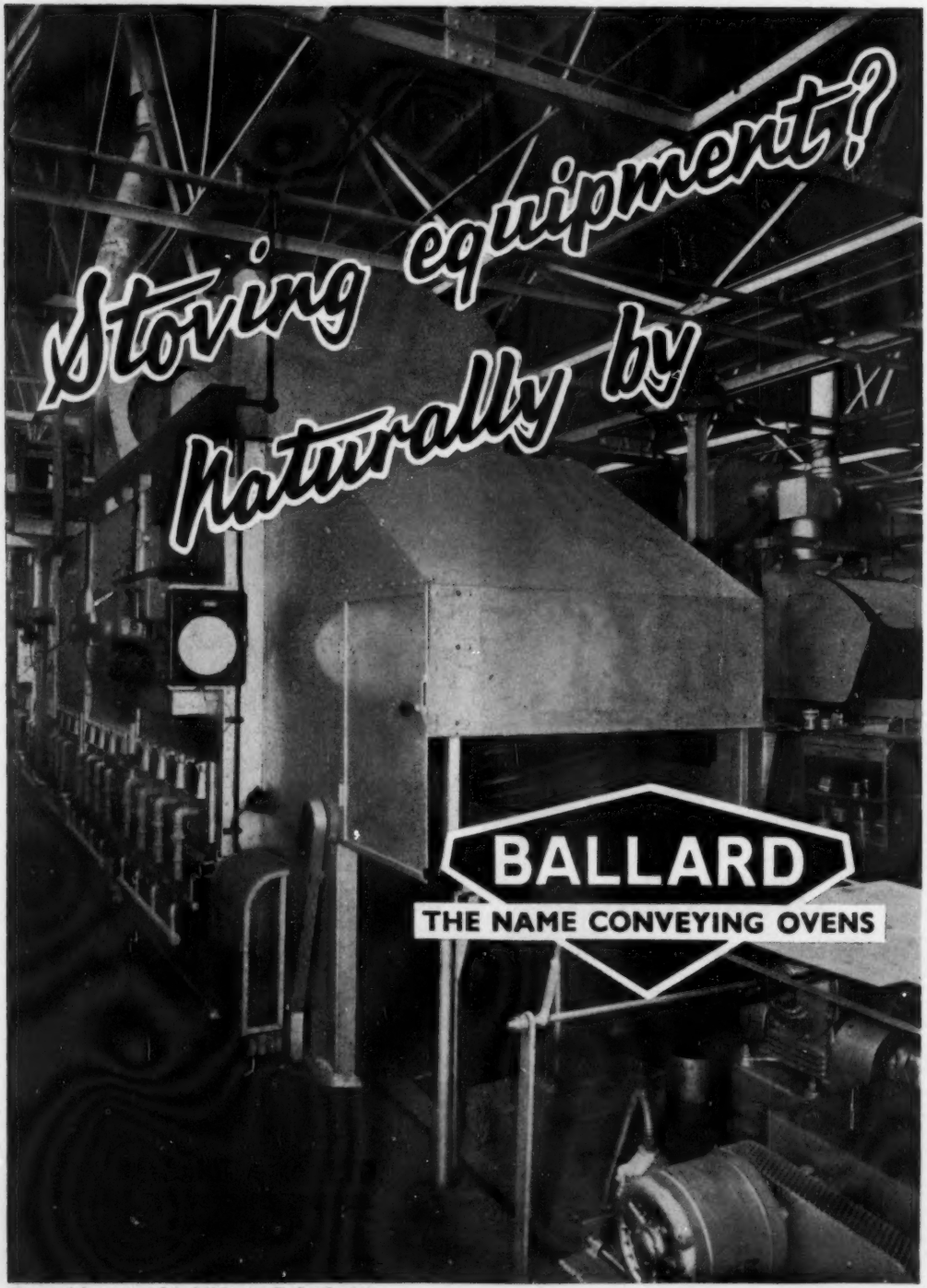
LSF 12



LSR 61



SGR 1



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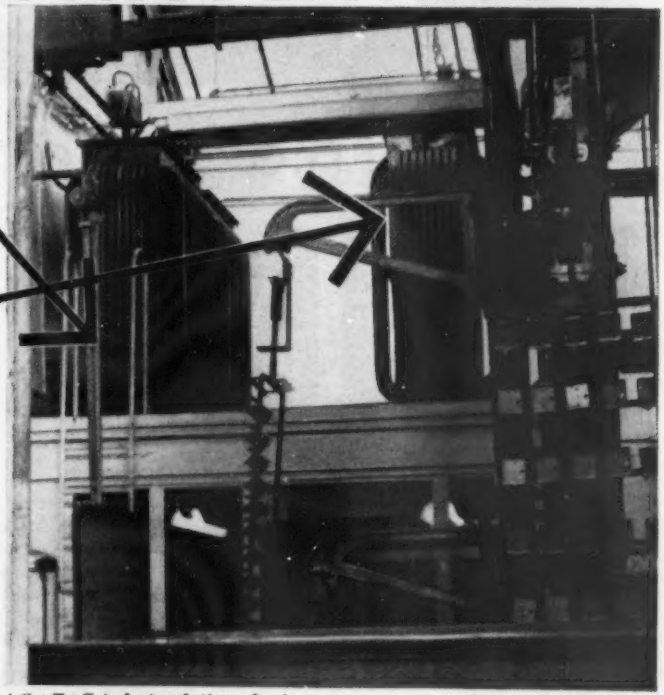

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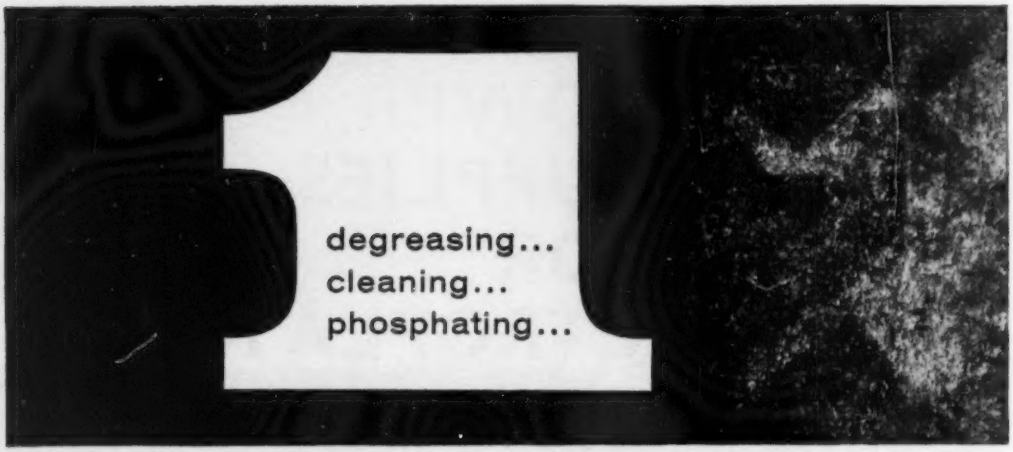

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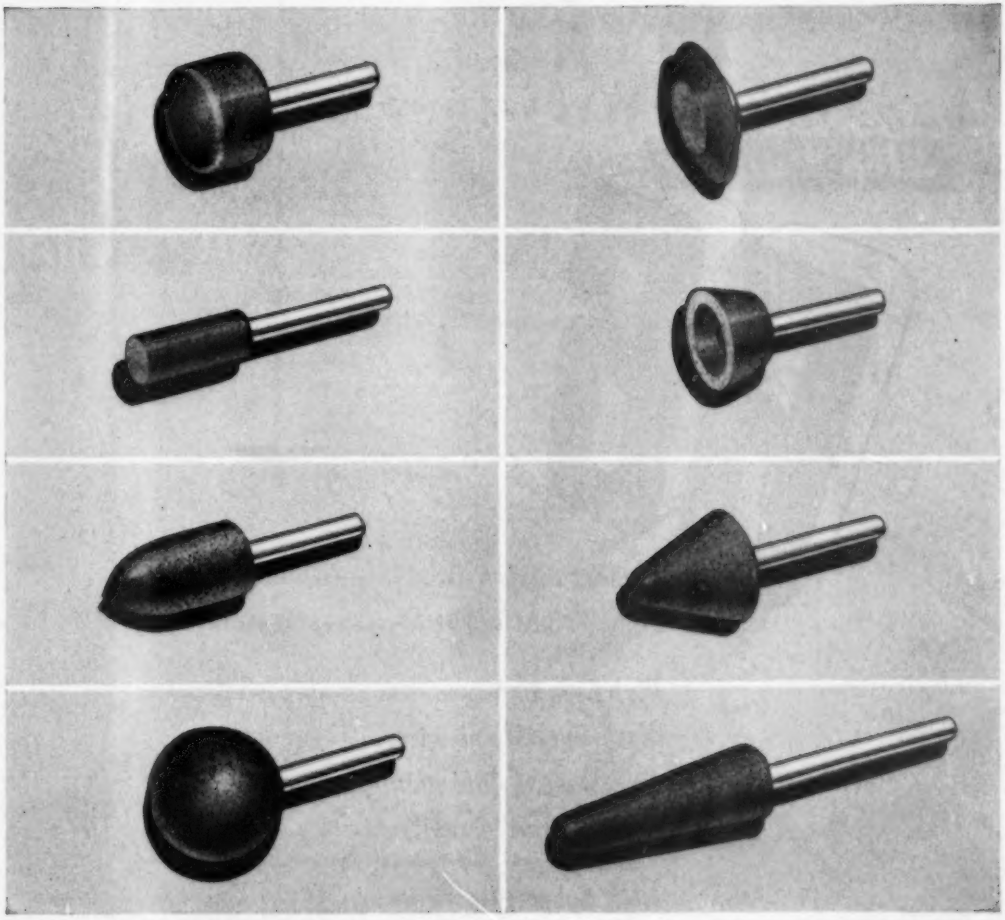

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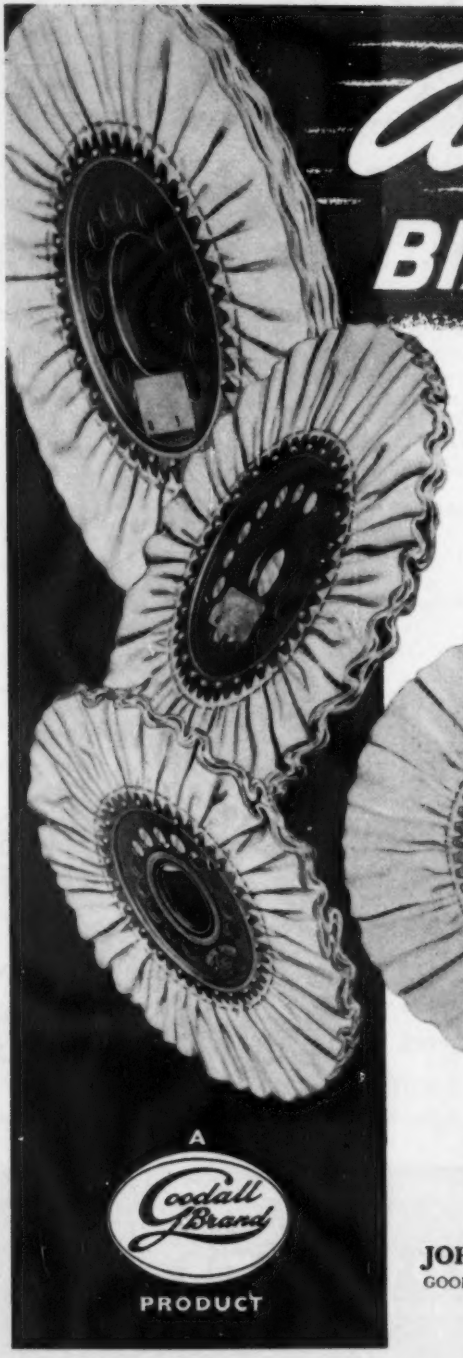

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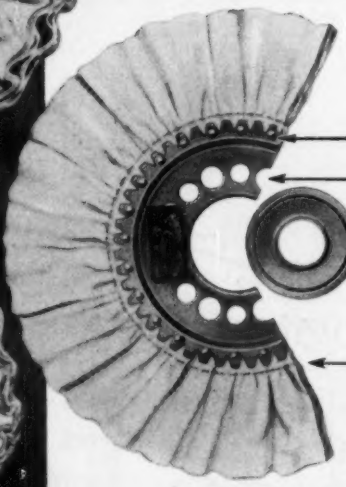
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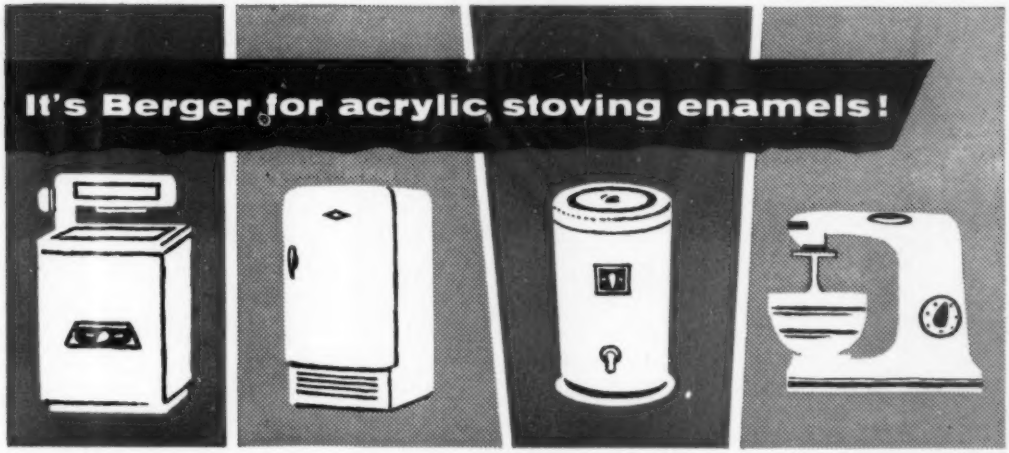

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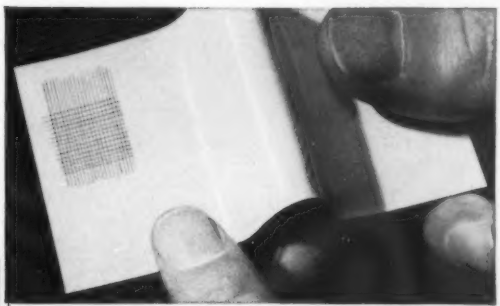

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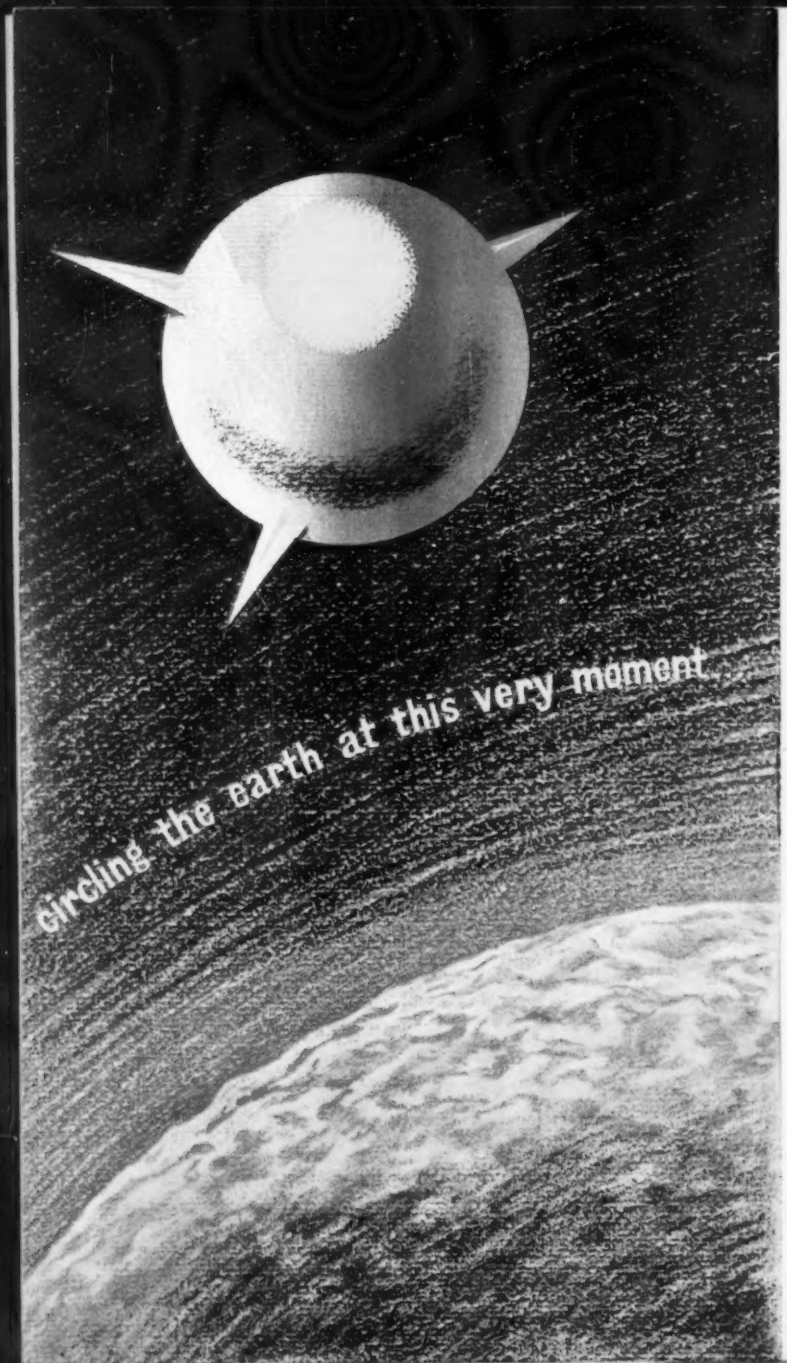

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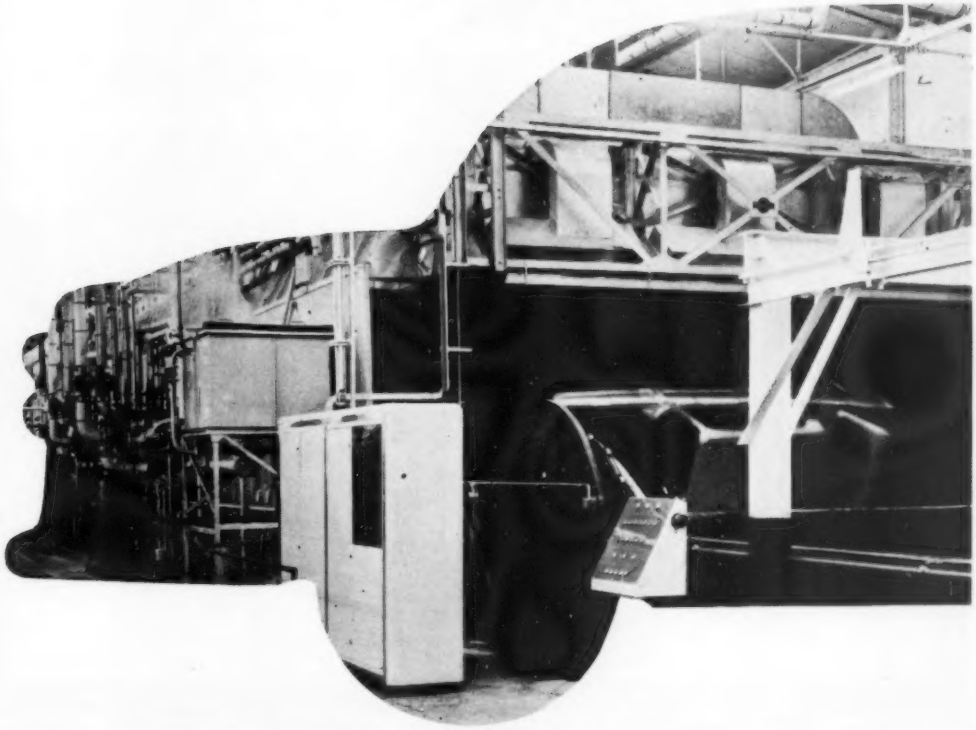

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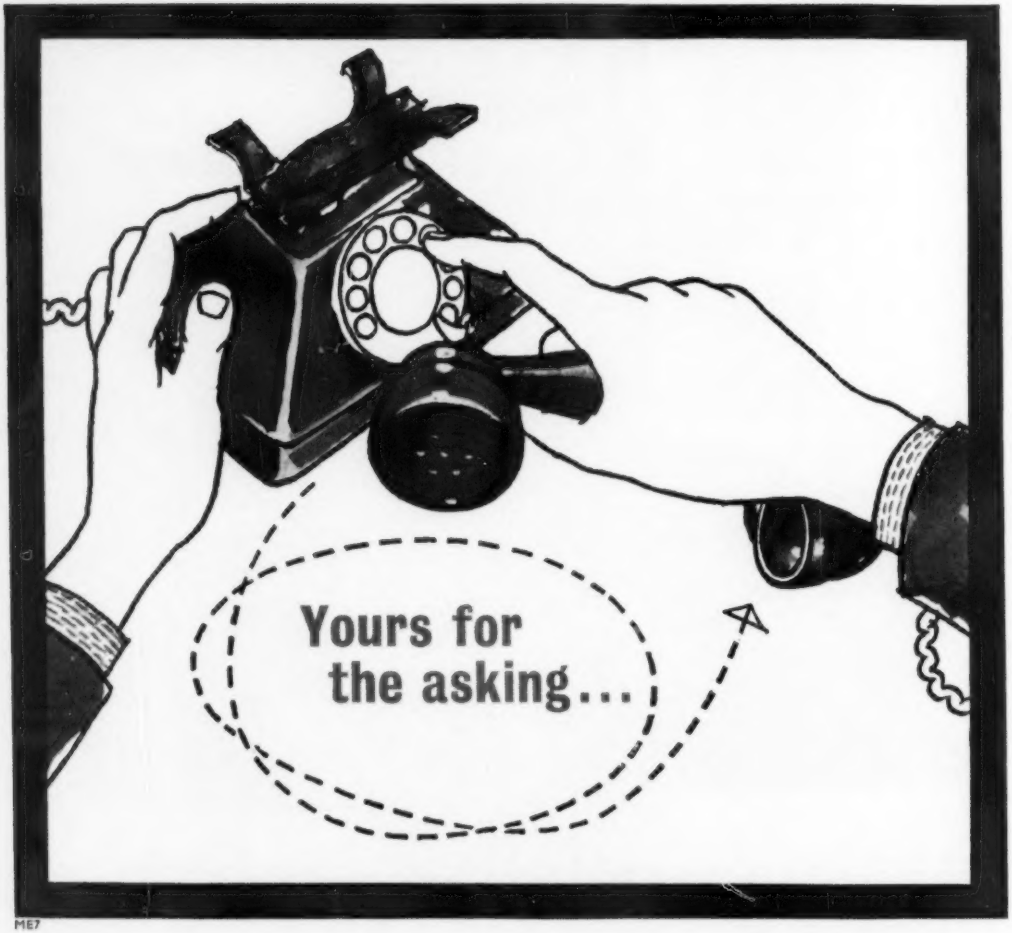

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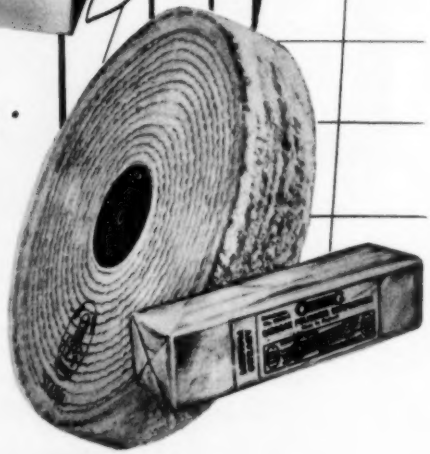

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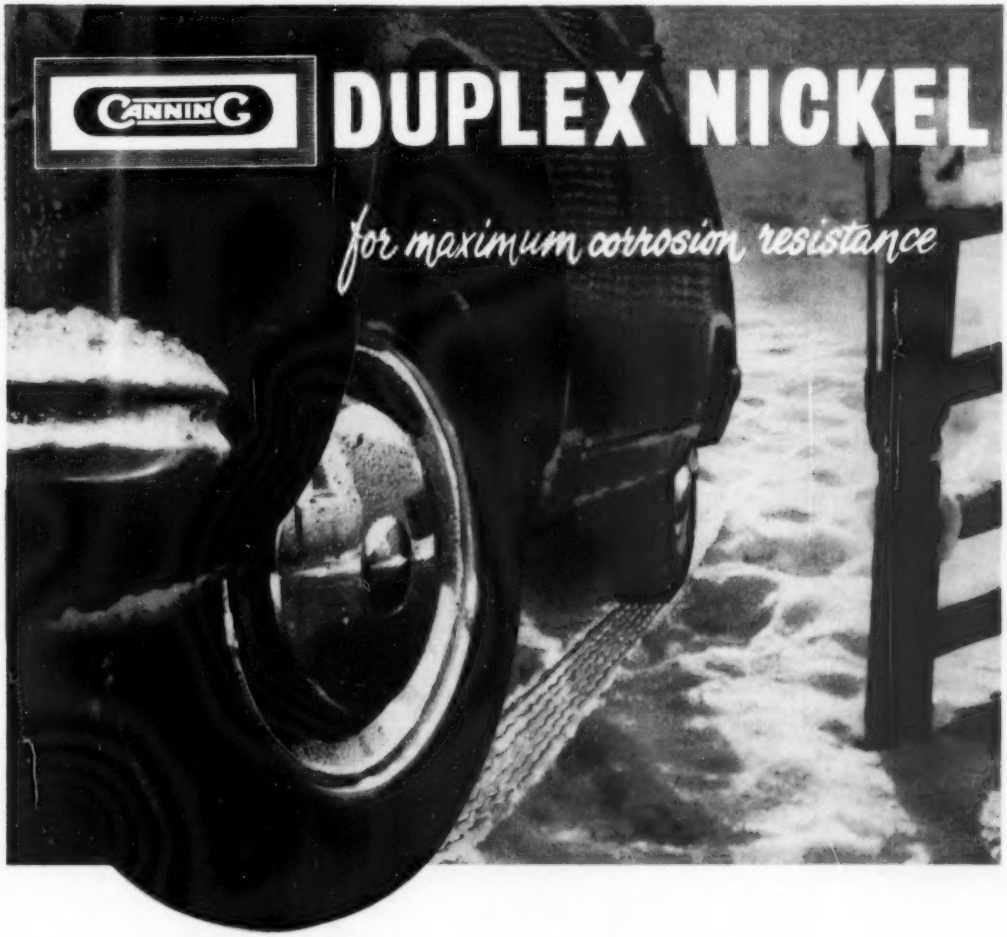

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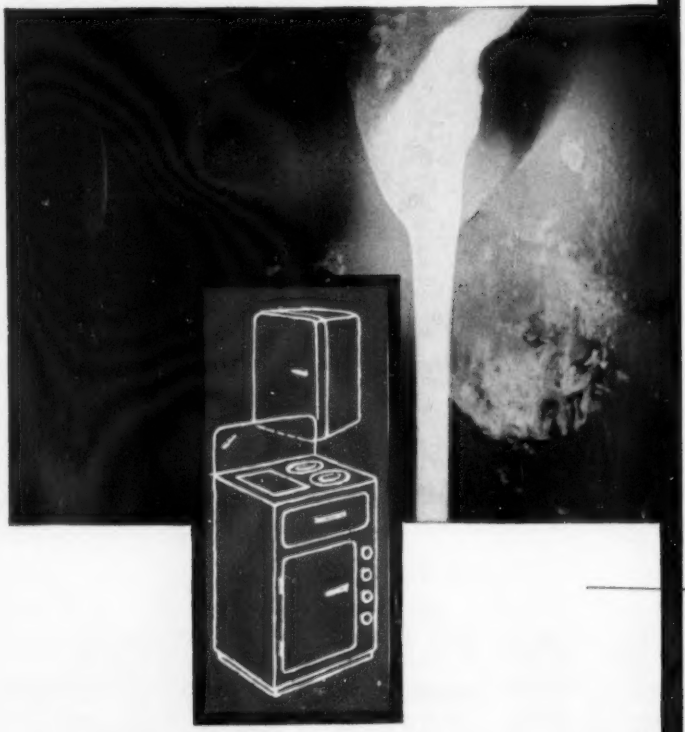

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THIS JOURNAL IS DEVOTED TO THE SCIENCE AND TECHNOLOGY OF PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, ANODIZING, METAL SPRAYING & ALL METAL FINISHING PROCESSES. THE EDITOR IS PREPARED TO CONSIDER FOR PUBLICATION ANY ARTICLE COMING WITHIN THE PURVIEW OF "METAL FINISHING JOURNAL" AND ALL SUCH ARTICLES ACCEPTED WILL BE PAID FOR AT THE USUAL RATES.

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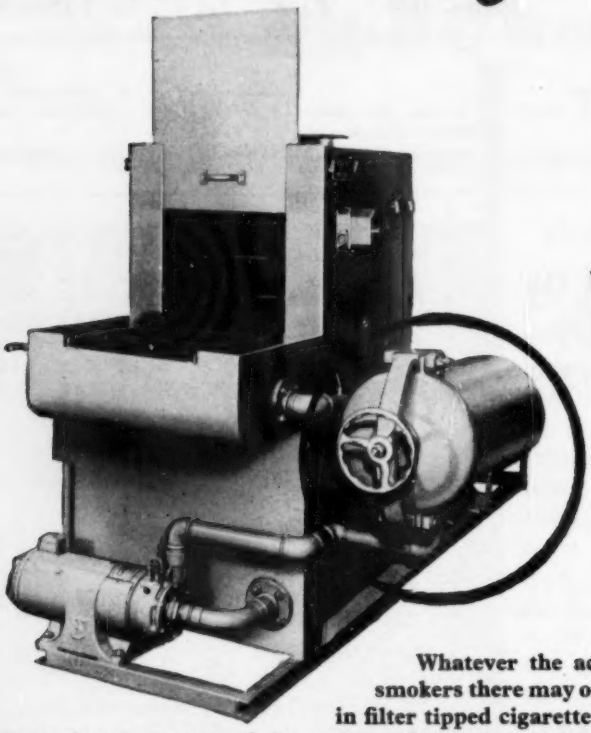
A FILTER TIP
in metal cleaning



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EXPANSION POTENTIAL

IT has been said that the degree of civilization achieved by a nation can be measured in terms of its system of internal communications ; on this scale some central African tribes must rate very high if all the tales of the efficiency of their jungle telegraph systems have any foundation in fact. It is however to a very great extent true that the progressiveness of an industry or of a technology is reflected in the state of its internal communications, and the hot-dip galvanizing industry is a very typical case in point.

For many years the hot-dip galvanizing process languished within the domain of the alchemist and the witch doctor, and communications between the constituent parts of the industry were negligible. In 1949 the formation of the Hot Dip Galvanizers' Association, and in more recent years of the European General Galvanizers' Association, wrought a notable change in this state of affairs, and by fostering the exchange of information greatly encouraged development and progress in the industry. The series of international conferences on hot-dip galvanizing initiated in 1950 by the Zinc Development Association on behalf of the H.D.G.A., has made its own special contribution, and advance notice of the sixth in the series to be held next year appears elsewhere in this issue.

Galvanizing is basically a simple process which has for very many years enjoyed deserved acceptance as an efficient method of protecting ferrous components from corrosion. In some sections of the industry, notably in the manufacture of steel windows and in the continuous hot-dip galvanizing of steel strip, considerable technical advances have been made, but at the same time a significant proportion of the general galvanizing industry is composed of small units in many of which the methods used differ very slightly from those of a hundred years ago.

In these cases there has perhaps been insufficient incentive or pressure to bring about a radical examination of standards of efficiency with regard to the galvanizing operations themselves. Corrosion prevention is at the present time a highly fashionable topic, and by taking advantage of the findings of technical discussion at national and international levels, to improve techniques and reduce costs while maintaining or improving the quality of the finish, galvanizing can look forward to even wider employment as one of the basic systems for the protection of iron and steel.

The field of structural engineering is one which offers considerable potential for extending the application of galvanized coatings. Many organizations operating in this industry have their own galvanizing facilities, but for the greater part they make use of the services of the general or jobbing galvanizer. Much could be done to increase the efficiency of those services, as for example, by concentrating specific types of work in continuous or semi-continuous lines as is being done in the American industry and in some special product lines in this country.

While it is obviously necessary for the particular requirements of the galvanizing process and the properties of the zinc coating to continue to be examined and improved where possible, it would appear that future expansion in the galvanizing industry may depend on the wider application of modern production methods.

Talking Points

by "PLATELAYER"

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

REVERSED DEPOSITS

RECENT findings in the United States that standard deposits of nickel between two layers of chromium have quite remarkable corrosion-resistant properties, may eventually change the conventional nickel-chromium plating sequence as we know it. The indications so far are that steel plated by this method will withstand the most severe conditions of exposure, but unfortunately few large-scale plating installations are designed to cope with the problem of applying the new system.

One of the problems which will have to be studied is the adhesion of nickel to chromium, about which little is yet known. A recent paper in the Journal of the Electrochemical Society throws some light on the subject. The considerable differences in the thermal expansion of nickel and chromium can lead to lifting of the deposit, particularly where high curvatures occur in conjunction with heavy coatings. One method of improving adhesion which has been suggested is to use a glacial acetic acid etch. This, however, is not a particularly nice material to use in production, apart from its high cost, its odour being sharp and irritating. It would also no doubt be disconcerting to arrive on a cold morning to find that the etching bath had gone solid overnight !

A FINE PICKLE?

ANOTHER of the old established processes which has stood the test of time in the metal-finishing industry is the pickling of copper and its alloys, including brass, in a nitric-sulphuric acid mixture. The acid is corrosive, the nitrous fumes evolved are toxic, and the entire operation is about as unpleasant as can be, yet there is no generally accepted substitute for the method, particularly where a bright-dipped finish is wanted.

There are, of course, substitutes for the oxidizing constituent of the mixture (nitric acid) which make the process easier to use. Among the better-known modifications are those in which chromic acid or sodium dichromate are employed in conjunction with sulphuric acid. The finish obtained, however, is more dull than with nitric acid, and hence has not always been acceptable to those familiar with the brighter finish obtained from the conventional dipping solution.

Another alternative method of pickling brass has been to use a ferric sulphate solution, and this system enjoyed a temporary vogue a few years ago; little is heard of it now.

In the United States, an attempt is currently being made to introduce a pickle for brass based on ammonium persulphate. Persulphates attack copper and its alloys quite rapidly and uniformly, and have, in fact, been used as an alternative to ferric chloride in some cases in the etching of the copper laminate in the manufacture of printed circuits. The suppliers of the new pickle claim that the cost is low, and there is no toxic hazard when it is used. Less credible, however, is the claim that "pinholing" is reduced by as much as 70 per cent when brass pickled in the persulphate bath is subsequently nickel plated.

"TRAVELLING"

WHY do people who are about to, or who have travelled abroad on business think it necessary to publicise the fact in trade and scientific publications? A recent notice typical of the genre, reads as follows: "A tour of several European countries, including Switzerland, Germany and Italy, has just been completed by Mr.—— and Mr.——, directors of ——."

It is interesting to speculate as to what effect an announcement such as this is intended to have on the reader. Perhaps that the company is on its toes to such an extent that its directors are even prepared to travel abroad in the furtherance of its business; and that the company is, moreover, sufficiently solvent to be able to afford the fare. If this is the intention, in these days where foreign travel is so quick and commonplace, such announcements are very much relics of the Victorian era.

It might be argued that the purpose of advance notices of directors about to visit agents and others abroad is to tell people that they will not be available for a while, but even this seems an unnecessarily elaborate way of doing so.

At best, these announcements seem to be a waste of time and paper, and most of them could well be dispensed with.

SUCCINCT

"SILICON rectifiers generally shall be employed where the bunching of oil cooling selenium rectifiers is not desirable because of fire hazard and where germanium rectifiers require, due to their heat sensitivity in the case of elevated outdoor temperatures, a disproportionately high amount of energy for cooling which would reduce again the high efficiency these units have initially."

From "German Exporter."

MECHANICAL PLATING

Some Details of the "Peenplate" Process

By D. E. J. CUNNINGHAM*

MECHANICAL plating by the "Peenplate" † process is a method by which small hardwear may be coated with zinc or other soft metals without the use of electricity. The process was developed in the United States by the Tainton Co. where it is now firmly established for coating nails, washers, chain, springs, and other small parts, many of which present some difficulty in coating by the conventional methods of hot-dip galvanizing or electroplating. The process itself is a method of cold welding by a modification of barrel-finishing technique. Parts are plated in a finishing barrel by tumbling with impact material, water, powdered metal and chemicals to promote the migration and welding of the powder to the parts.

Most of the plants working on any scale are used to apply zinc to steel parts but there are other installations for applying other metals such as cadmium, tin, lead, copper and various alloys to steel or other metals. Coatings can be applied to many non-ferrous metals and even to some non-metallic substances such as ceramics. Suitable articles for mechanical plating include nails, washers, springs, powder-metallurgy parts and in fact most small stampings or wire articles.

The equipment may be relatively simple, the only essential piece of plant being a tumbling barrel and most of the pre-treatment and separation can be carried out in dipping tanks and hand sieves. The barrel itself should be rubber-lined and is usually hexagonal or octagonal to give the necessary energetic action. Successful plating has also been carried out in vibrating troughs but the amount of mechanical energy available with conventional equipment is usually rather limited and leads to very long plating times. Barrels should have a variable-speed drive as speed of rotation is one of the variables which can affect the final coating. For large-capacity plants, more elaborate equipment has been installed in which parts are pre-treated, plated and then rinsed and dried after separation from the impact material by modern methods of mechanical handling.

Before plating the parts must be thoroughly clean and free from grease. They should have a very thin coating of copper and a slight etch which may be produced by pickling or abrasion. Parts contaminated by grease are usually degreased either by solvent vapour or hot alkali. In practice it has been found that hot alkali gives a cleaner surface than that produced by vapour or solvents although heavy contamination by persistent greases such as lanolin may best be treated by both vapour degreasing and immersion in hot alkali. Degreasing should be sufficient for no water break to appear after rinsing the parts.

Pickling in hydrochloric or sulphuric acid may be used to remove rust or heat scale and also to etch the surface of the object to improve the adhesion of the coating. If acid pickling is considered undesirable the parts may be lightly grit-blasted with fine abrasive or tumbled with abrasive and water containing chemical cleaning agents. The thin copper coating is particularly useful to aid the "strike" of zinc. Dipping in a warm acidified solution of inhibited copper chloride gives a suitable coating although successful results have been obtained by tumbling parts for 2 to 3 minutes with a dilute acidified copper-sulphate solution in the barrel.

If a copper dip should be considered undesirable for any application, the strike may be provided by an addition of another metal to the plating metal; for example tin aids the strike of zinc, and lead aids the strike of copper or brass.

It is not essential to adhere to the foregoing methods of pre-treatment and in practice the pretreatment process is usually tailored to the job in hand. As an example of this it was found to be extremely difficult to give wire nails sufficient cleaning to guarantee good plating with every batch. This is due to the presence of wire drawing soap, a form of calcium aluminium stearate, which is only removed with difficulty by the hot alkali treatment followed by a hydrochloric-acid pickle.

*F. W. Berk and Co., Ltd., (Coating Division)
†"*Peenplate*" *is a registerd Trade Mark.*

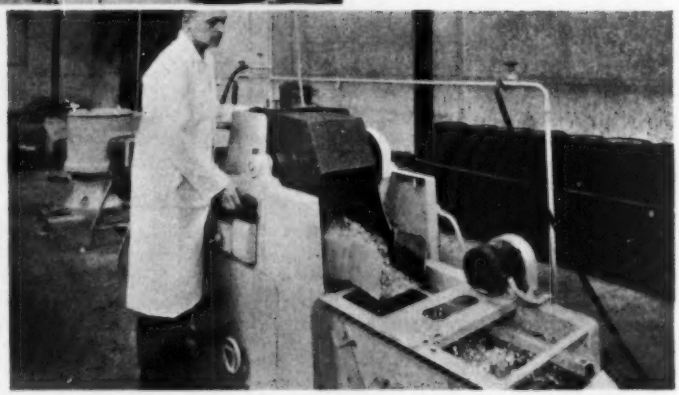

Fig. 1—(left) and Fig. 2—(below) Two views of Peenplating equipment of F. W. Berk and Co. Ltd.

When the solutions are fresh the process works well enough but after a few runs free stearic acid is deposited on the nails and quite a quantity may be observed floating in the acid pickling vats.

It was evident from their shape that nails are self abrading, and a cleaning action would take place by simply tumbling them in a finishing barrel. After a certain amount of trial and error it was found that suitable cleaning would be effected by tumbling the nails with about 5 per cent of graded sharp flint grit mixed with ½ to ¾ per cent of lime and just sufficient water to make the alkaline abrasive adhere to the nails. A typical batch would be 200 kg. of nails, 7½ kg. of coarse flint grit, 2½ kg. of fine flint grit, 1 kilo of slaked lime (calcium hydroxide) and 1 to 2 gal. of water. Tumbling for forty minutes with this mixture is nearly always adequate to remove the drawing soap and any traces of grease that may be present, although the process will not remove heavy mineral grease. In addition to providing a scouring action the sand produces a sufficiently fine etch for successful plating to take place. The alkaline abrasive is readily rinsed away from the nails and if necessary a rapid rinse using some of the promoter chemicals will provide additional cleaning. Coppering nails prepared in this manner usually takes place in the barrel by adding a calculated quantity of acidified copper sulphate or inhibited copper-chloride solution so that the charge does not have to be removed from the barrel until they are completely plated.

Impact material may be spherical or irregular and metallic or of certain non-metals such as fused alumina and glass. Metallic impact material has the disadvantage that it has to be coated with the metal in use. This is quite successful with copper and brass plating where heavy impact material such as steel wire cuttings, nail nippings or lead shot are an advantage. With zinc plating however, where the maximum utilization of powder is essential it has been found that the most suitable material consists of a mixture of different sized glass balls. The selection and grading of the impact material charge is a matter of experience and some experiment. If plating is required in recesses it is essential to have a small glass ball which will penetrate into these recesses, but it should not be of such a size that it will jam. Small glass balls give a smooth bright coating whereas the larger sizes give a pebbly coating which may suffer from poor adhesion. It is, however, necessary to include large balls to prevent inter-object activity, in particular with large heavy objects which would otherwise readily impinge against each other and chip the coating. The ratio of impact material to parts is usually 1/1 and 4/1 by weight.

Light objects like small panel pins can be plated with a 3/4 impact material/part ratio although small nails require a 1/1 ratio. Large nails, washers, chain and most small stampings require a 2/1 ratio

while heavy bolts, small castings, powdered metal parts and parts made out of thick plate will require even more impact material to prevent chipping. Chain may be readily plated by this process, although very long single lengths require bundling to prevent tangling in the barrel. Such tangling would result in links locking together and areas of the chain being left unplated. As an additional precaution, the direction and rotation of the barrel should be frequently reversed. Once the mixture and ratio of impact material has been settled the action of the barrel may be softened by reducing the speed or filling it until very little space is left in the top.

The promoter is usually sold as a solution of chemicals containing an acid to remove oxide films from the basis metal and metal powder particles, as well as surface active agents and inhibitors ; it is formulated so that two pints of promoter are added for each 1 cwt. of parts or 1 litre to 50 kg. Weak organic acids are normally used as these are non-toxic and do not give rise to hydrogen embrittlement. One of the essentials of the process is that the promoter residue will not present any effluent problems. A small quantity of anti-foaming agent is added to a charge for barrelling as the presence of foam may give rise to dangerous pressures, which could cause inconvenience or injury to operators. It has also been found that foam will hold small glass balls in recessed parts and cause non uniform plating. The tendency to foam varies to some extent with the hardness of the local water and therefore instead of adding anti-foaming agents to the promoter chemical water soluble silicone emulsions are added repeatedly in the proportion of 1-1½ cc. per 50 kg. of parts.

Metal Powder Sizes

The metal powders used for mechanical plating should contain the finest particle sizes commercially available. Spongy particles or leafing particles are undesirable as the surface area/weight ratio is high and the quantity of oxide is correspondingly high. The quantity of metal powder added to a charge is calculated on the basis of the total coating thickness and total area of the charge, making due allowance for the fact that between 90 to 95 per cent of the powder included will be plated out. The deposition efficiency decreases as the oxide content increases, and therefore powders should always be kept in sealed containers until ready for use, and if possible open containers should be used up within two or three weeks.

The quantity of water necessary for any given charge is determined by experiment, as it is usually just sufficient to cover the charge by about ½ in. after tumbling. If a charge of nails or wire parts such as hose clips are placed in a barrel followed by the impact material, it is possible to pour a very large volume of water into the barrel before the unmixed charge is covered, and therefore for initial runs it is important to ensure thorough mixing to make an accurate determination of the quantity of water required. With heavy objects which may suffer from interobject activity the quantity of water is slightly increased so that 2 to 3 in. cover the mixed charge. An excess of water often leads to low powder utilization.

The mechanism of zinc plating has been the subject of considerable study, and it is likely that the mechanical plating of other metals follows the same pattern. The strike of zinc is improved by a very thin film of chemically deposited copper.

Fig. 3 — Peenplating installation at American Hardware Co., Connecticut, U.S.A.

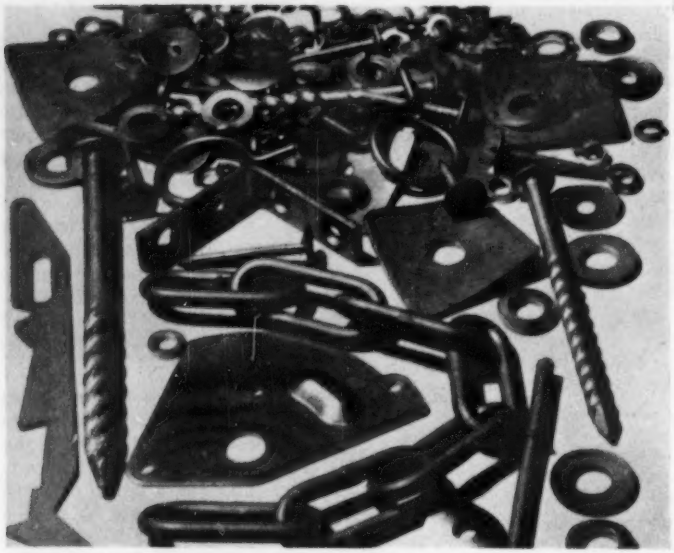

Fig. 4—Typical components suitable for coating by the Peenplating process

As this is formed only a few minutes before zinc plating commences, there will be very little oxide on the copper surface, and that which has formed is relatively soft. The promoter removes oxide from the zinc particles and with the aid of mechanical impact a true metal-to-metal contact is made and some degree of cold welding takes place. The slight etch produced by the pre-treatment assists in obtaining adhesion in the same manner as a metal sprayed coating adheres to a shotblasted surface. During plating an induction period takes place in which nearly all the zinc is deposited on the surface of the objects as a dull grey paste, which may be readily removed by rubbing with the fingers. Further barrelling consolidates the coating, and increases its adhesion and density. In the case of easily platable parts such as nails and washers the paste coating deposit is completed in about 5 minutes and complete consolidation takes a further 15 to 20 minutes. The process is usually run for a further 5 minutes to obtain a brightly polished effect but this last few minutes does not contribute anything to the durability of the coating. Over-running will tend to chip the coating at exposed edges or projections. Where very thick coatings are required it is an advantage to add the metal powder and promoter in two portions and slow down the whole cycle. This also assists penetration into recesses. The coating is laminar in structure owing to its formation from impacted particles but it is much less porous and smoother than metal sprayed coatings owing to the difference in particle size and relative better close packing. The coatings have shown a high degree of uniformity on irregular shaped objects although some degree of difference in coating thickness is to be expected on threads, in the same way as with other processes.

The adhesion of mechanically plated zinc coatings has proved to be quite satisfactory for most practicable purposes. Plated nails may be hammered into wood and withdrawn without any coating damage, and plated chain will not show any adhesion failure after considerable use in which links abrade against each other. Plated washers may be bent through 90 deg. without obvious flaking.

Corrosion Resistance of Coatings

The corrosion resistance of the coatings depends on coating thickness in the same way as similar coatings produced by electrodeposition or hot dipping. The normal coating thickness for small objects is 0.0003 in. to 0.001 in. many objects are coated to 0.002 in. and heavy objects such as rail ties have been successfully coated with 0.004 in. These last are very heavy, weighing over 1 lb. each, and have a relatively rough finish, giving rise to high impact energies in the barrel and an ideal surface for plating.

The advantages of the "Peenplate" process include the ability to apply a bright smooth coating at low cost. The coating thickness may be varied at will and no hydrogen embrittlement occurs on spring parts. Many alloys can be plated which would be difficult or impossible to deposit electrolytically and finally no high degree of operator skill is necessary for even the largest installations.

METALLIZING

Steel Wire by Immersion in Molten Aluminium *

By KAREL JANECKY †

THE former method of metallizing by immersion in liquid zinc is sharply criticized at the present time, from both the economic, and also the functional aspects. The general shortage of zinc, and the rise in its price on world markets, present the production of galvanized materials with important problems over the supply of zinc. Various measures are being carried out to save zinc, former technical methods of galvanizing are being reviewed, and new ones are being advanced. There is no method however, of solving the basic difficulty, namely the shortage of zinc. There exists only one course, therefore, zinc must be replaced by another metal which will fulfil the requirement of anti-corrosive protection of the basic ferrous material. This problem can be solved by the use of aluminium, and although metallizing by immersion in aluminium places greater stress on the maintenance of technical operating conditions, basically it is the same as other immersion methods. Fundamental experiments have shown that even at the present time it is possible to carry out aluminizing by immersion industrially, in instances where the necessary technical conditions can be maintained ; it is especially suitable for continuous processes, such as the metallizing of wire or strip. At the present time, in a number of countries, continuous plants have been put into service for the aluminizing of wires by immersion almost simultaneously and independently of each other. This is evidence that this is a suitable method by which to overcome the shortage of zinc.

Basic Techniques

The technique of aluminizing wire by immersion is, in its individual stages, based on familiar operations : degreasing, pickling, application of flux, aluminizing and cooling of the aluminized wire. In order more readily to improve the economy of this new method of metallizing of wire, special new technical principles have been developed, which are distinguished both by the individual operations employed, and also by the use of new methods which have not hitherto been used in this sphere. Roughly it is possible to divide up former techniques into three groups, which are distinguished mainly by the use of the flux :

1. methods based on the principles of an aqueous solution of the flux ;
2. methods based on the principle of the use of flux in the form of a salt solution ;
3. methods employing a reducing atmosphere instead of a flux.

In essence it is impossible to determine which of these methods is the most advantageous, both from the economic, and from the technical point of view. This depends mainly on the economic situation and on the readily available, basic raw materials, mainly for the flux.

1. Methods based on the use of aqueous solutions of flux are technically the simplest, and economically the most efficient. An aqueous solution can be easily prepared, easily controlled and easily maintained. The flux is readily melted off the wire, and does not form undesirable and harmful products. Chemicals for the preparation of such a flux are, however, relatively costly (from the point of view of their use in the Czechoslovak Republic), since for the most part compounds of zirconium, lithium, etc. are involved, such as potassium fluozirconate (K_2ZrF_6) or anhydrous

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* A translation of an article in *Hutnik* (Prague), 1960, **10** (2) pp. 61-64

†The author is with the State Research Institute for the Protection of Materials, Prague.

potassium fluotitanate (K_2TiF_6). These chemicals are used for the familiar Lundin method[1]. Wire which has been pickled and well washed is wetted in a flux of composition 2 to 18 gm. K_2ZrF_6 per 100 cc. water, the solution being used hot (at 100°C). Before passing into the aluminizing bath, the flux on the wire is dried with hot air. The method described is employed in the USA at the American Chain and Cable Company, Inc., which has an annual output of almost 100,000 tons of aluminized wire.

Good results were obtained in Czechoslovakia at SVUOM (State Research Institute for the Protection of Materials) with the use of a flux based on borax with the addition of ammonium chloride[2]. The warm solution has a composition of 5 to 15 parts by weight $Na_2B_4O_7$, 1.5 to 3 parts by weight NH_4Cl and 200 parts by weight H_2O. Where this flux is used, a suitable temperature for the aluminizing bath is 740 to 750°C.

The use of aqueous solutions of flux based on zinc, sodium and potassium chlorides and those of other metals has not proved satisfactory. This flux does not readily melt off the surface of the wire, so that it is necessary to pass the wire through the baths at low rates, which is unsatisfactory from the economic point of view.

2. The use of fluxes in the form of salt solutions has many difficulties, both from the point of view of the actual technique, and also in relation to the plant, so that it has not hitherto been introduced on a production scale. Salt solutions can be used by two methods, either as a flux bath in its own tank, or as a coating layer on the inlet side of the aluminizing bath. Both methods have their advantages and disadvantages, but their common disadvantage is that a large quantity of the solute adheres to the surface of the wire ; on entering the aluminium this is incompletely dissolved, is transferred into the bath by the wire and burnt, and the combustion products adhere to the surface of the wire, which is thereby rendered valueless. At temperatures of 700 to 800°C a salt bath has little energy, since as a consequence of absorption of moisture from the atmosphere it is not stable. A distinct advantage is that a salt fluxing bath can be simultaneously a heating medium, so that the aluminizing is considerably speeded up, by about 20 times (here only the actual reaction between the aluminium and the iron is meant).

In Table I three suitable compositions of salt solutions are given.

3. The use of reducing or inert atmospheres has great importance for continuous processes, since it implies a simplification of the technical processes with a simultaneous increase in efficiency. The following method is used where reducing atmospheres are employed ; wire which has been pickled and well washed is led into an oxidizing

Table I

I		II		III	
KCl	47%	$CaCl_2$	15%	KCl	25%
NaCl	35%	KCl	10%	$MgCl_2$	20%
Na_3AlF_6	12%	NaCl	10%	NaCl	20%
AlF_3	6%	NaF	2%	$ZnCl_2$	33%
		$ZnCl_2$	10%	NH-Cl	10%

furnace, where at about 400°C a fine and continuous layer of ferrous oxide is formed on the surface by means of steam. The wire then passes out into a reducing furnace, where the oxides are again reduced into iron. Use is made of either a hydrogen atmosphere, or of a mixture of hydrogen (about 75 per cent) and nitrogen (about 25 per cent), the latter produced by cracking ammonia. The reduced iron is then characterized by a ready ability to combine with the molten aluminium. Inert atmospheres are therefore used in instances where it is necessary to prevent oxidation of the surface during the heating of the wire before passing it into the aluminizing bath. It is used with advantage for techniques not employing fluxes, where sand-blasted wire is heated in an inert atmosphere to the temperature of the aluminizing bath and is then aluminized. By this method a reduction of the immersion time is obtained, so that the formation of high-strength alloy layers in the coating is prevented, whereby the bending properties of the aluminized wire are improved. This method has been developed in Czechoslovakia[3], and tried out on a semi-production basis with very good results.

The Aluminizing Bath and its Composition

The aluminizing bath is normally of aluminium of commercial purity (99.5 per cent Al). It is not necessary to use aluminium of higher purity, since the small percentage of impurities has no influence on the properties of the aluminium coating. Coatings produced by aluminizing wire in the type of bath normally used, however, have inadequate bending properties, in consequence of the undue thickness of the alloy layer which is mainly of the Al_3Fe phase. It is indeed possible to decrease the thickness of this phase by reducing the temperature of the bath and by shortening the time of immersion, but in this way satisfactory results are not obtained. Other expediants must be used, *i.e.* alloying of the bath with a suitable element. In the bath an alloy which can, in fact, have different properties from that of a basically pure bath is produced. These are shown mainly by the melting temperature, fluidity, oxidation of the surface of the molten metal, activity of the bath etc. And though it is possible to use as alloying elements all metals which in the liquid state are soluble in aluminium, their effects are varied. Predominately, silicon is used, even al-

though beryllium and titanium are far more effective. These two latter elements are very expensive, so that a bath alloyed with beryllium is 400 times dearer than a bath alloyed with silicon.

An important and hitherto unsolved problem is the activity of the aluminium bath. The surface of the molten metal is strongly oxidized in contact with the atmosphere. Through the movement of the bath the oxides are stirred into the whole of the contents. The coating on the aluminized wire may then become granular and poor in appearance. The same applies to excessive amounts of flux. For continuous processes, however, this problem is not so pertinent, since it is easy to cover the surface of the metal with a lid, and fill the interspace with a neutral atmosphere. But the bath must be regenerated with gaseous chlorine at relatively short intervals. According to results taken from literature sources[4], it is necessary to repeat this operation not less than once in a shift.

A further problem is the dissolution of the iron from the material being metallized, or from the furnace bath. This iron combines with the aluminium bath and forms so-called hard aluminium, corresponding to the compound Al_3Fe. This hard aluminium causes losses of raw material, and essentially ruins the aluminium coating, in which it is deposited as lumps or nodules. The formation of hard aluminium cannot be completely suppressed, but by a suitable arrangement of the shape of the aluminizing bath or container, it is possible completely to cut out its influence. The bath must be sufficiently deep, so that the hard zinc is not stirred up by the material being metallized and can readily form a sediment. At definite intervals, however, this must be removed.

Properties of Aluminized Wire

Steel wire which has been metallized by immersion in molten aluminium, is properly speaking a semi-finished product intended for further working. Definite requirements will therefore be placed on the aluminium coating in respect of the mechanical properties, since aluminized wire will be predominately worked by bending, such as normally occurs during the production of tetragonal and hexagonal mesh wire netting and other wire products.

The essential property of aluminized wire is therefore flexure, *i.e.* the coating must have such mechanical properties that during flexure it will not fracture or peel off, since it will then be unable to fulfil the fundamental requirement of protecting the actual wire against corrosion.

As is well known a coating consists of several layers. Working in the direction from the base metal these are :

the iron base itself;

the alloy layer, corresponding to the phase Al_3Fe;

the real zinc coating.

The flexibility of aluminized wire is therefore a function of many factors not only from the point of view of the composition of the coating, but also of the temperature of metallizing bath, the time of immersion and the composition of the bath. The basic parameter which has an essential influence on the flexibility of aluminized wire is the thickness of the intermetallic phase and its mechanical properties.

During the immersion of steel wire into molten aluminium, first of all dissolution of the surface of the iron base takes place with simultaneous formation of the Al_3Fe phase. Next there then follows diffusion of Al_3Fe into the base metal. The thickness of this phase is directly dependent on the temperature and time of immersion, and therefore can exert a considerable influence on it by reducing the time of immersion and the temperature of the bath. The coating on aluminized material, through the effect of the high temperature of the bath remains for a relatively long time in the molten state, which promotes diffusion of the aluminium, even after the extraction of the object (the wire) from the aluminizing bath. By rapid cooling with air or water it is also possible to reduce the thickness of the alloy phase.

It is possible, however, to exert an influence on the mechanical properties of this phase, *i.e.* malleability, hardness and structure, only by alloying the bath with certain elements which will slow down or completely inhibit the diffusion of the aluminium into the iron, and promote structural changes in the composition of this phase. It is therefore necessary to emphasize that the composition of an aluminizing bath has exceptional importance, both economically and technically. The composition of the bath has a basic influence, likewise, not only on the mechanical properties of the coating and on its appearance, but also on its anti-corrosive properties.

Coatings obtained with pure aluminium are mechanically unsuitable, since the high-strength alloy phase breaks up into small pieces during bending, and thereby the bond between the real coating and the base metal is ruptured. The coating extensively peels off.

There are many reasons for alloying aluminizing baths. The most important of these are :

a) Some alloying elements facilitate aluminizing by the fact that they reduce the melting temperature of the alloy and increase the fluidity of the bath, which promotes the wettability of the aluminium in relation to the steel :

b) Some alloying elements have an influence, on the sequence of diffusion of aluminium into iron in the sense that they retard the diffusion

velocity. This results in a reduction in the thickness of the Al_3Fe phase. Apart from this it also affects the hardness of this phase and its brittleness, and this is manifested in an increase in flexibility :

c) Other alloying elements have an influence on the appearance of the coating through the fact that they prevent the formation of oxide films on the surface of the bath and on that of the coating itself. Alloying elements can also exert an influence on the crystallization of the solidifying aluminium coating.

The most important alloying element is silicon. Silicon reduces the melting point of the bath, which makes it possible to work at lower temperatures, while in addition it substantially reduces the diffusion velocity ; its consequence is a reduction in the thickness of the alloy layer. Apart from this, silicon brings about changes in the composition and structure of this layer. All the influences mentioned are manifested by an increase in the flexibility of the aluminized wire. In a successful bend test on aluminized wire of 2 mm. diameter, carried out by bending the wire around its own diameter, a very severe test, the coating used was obtained from a bath alloyed with 2 per cent silicon at a temperature of 680°C. A 2 per cent concentration of silicon proved to be the most suitable ; at a higher silicon content the coating did not have good bending properties, since at some points it splintered off. This is probably brought about by an accumulation of the eutectic in the top layers of the coating. Apart from this a high silicon content gives rise to darkening of the colour of the coating and general deterioration in its appearance. On the anti-corrosion properties, however, this has no influence.

A further important, but undesirable alloying element is iron, which finds its way into the bath through the dissolution of the wire being treated, and through the dissolution of the various current conductors immersed in the bath. If the content of iron in the aluminizing bath is greater than 2.5 per cent the intermetallic compound Al-Fe is formed, which causes a rough surface on the aluminium coating on cooling. The concentration of iron in the bath can be reduced by cooling it to about 670°C. The low temperature can, however, give rise to crystallization of other alloying elements in the form of intermetallic compounds, so that the bath is impoverished in the alloying addition, and must be supplementarily alloyed with new alloying material. If the bath contains more than 2 per cent Fe, the flexibility of the coating is reduced ; 1 to 2 per cent Fe, on the other hand, heightens the lustre of the coating, especially if about 2 per cent of silicon is present.

Other alloying elements, such as beryllium, titanium, chromium, molybdenum, magnesium, etc., have secondary importance from the economic point of view[5], even although some of them (Be, Ti) are extremely efficient. Beryllium is 20 times more efficient, and titanium 40 times more so, than silicon, but they are essentially more costly. A bath alloyed with beryllium is 400 times more expensive than a bath alloyed with silicon. A content of 0.6 per cent Be in the bath reduces the thickness of the intermediate layer by 80 per cent and a content of 0.1 per cent Ti by about 85 per cent. Against this, small quantities of beryllium (0.01 to 0.1 per cent) reduce the flexibility of the coating. A good property of beryllium is that it substantially restricts oxidation of the surface of the metal of the aluminizing bath. An addition of 0.04 per cent Be to a bath alloyed with silicon prevents discolouration of the coating.

A content of 0.002 to 0.009 per cent of sodium increases the " wettability " of an aluminizing bath and increases the adhesion of the coating. If sodium is added in the quantity indicated to a bath alloyed with silicon, this brings about even distribution of the Al-Si eutectic, so that the flexibility of the coating is increased.

Boron, titanium, chromium, molybdenum and zirconium added to a bath alloyed with 2 per cent Si greatly heighten the lustre of the coating[6]. Molybdenum, apart from this, considerably increases the " wettability " of the bath. Manganese and zinc also improve the " wettability " of the bath and facilitate the Al-Fe reaction. In conjunction with silicon, however, they do not have any clearly marked effect. Suitable concentrations of the elements mentioned are shown in Table II.

Table II

Element	%	Element	%
Boron	0.03	Zirconium	0.20
Titanium	0.05	Vanadium	0.20
Chromium	0.15	Tungsten	0.20
Molybdenum	0.15	Zinc	0.50

It is impossible to alloy an aluminizing bath with several elements simultaneously. Mutual combination is restricted, because certain elements have a tendency to form intermetallic compounds with aluminium.

The alloying elements must be added as technical alloys prepared in a ratio of 1 : 1, which makes possible, and speeds up, dissolution in the molten aluminium. Where beryllium is used, it is necessary to bear in mind that a definite part of the beryllium is consumed in restricting the oxidation of the surface of the metal of the bath, so that the correct concentration must be investigated.

It is necessary to clean the aluminizing bath with gaseous chlorine to remove oxide. Chlorine,

(*Continued in page* 319)

Metal Finishing Technology — A Students' Guide: 4

An Introduction to the Examination Syllabus in Metal Finishing of the City and Guilds of London Institute

Compiled by A. ALEXANDER

ELECTRICAL PLANT

Control of Rectifiers

THERE are two main methods of controlling the output of a rectifier, the first by varying the tappings on the primary windings of the transformer and the second by using a small auto-transformer to vary the primary voltage. The first method may be used when only a small amount of variation is required. If, however, the rectifier is designed to give an 8-volt output and it is desired to reduce this for control purposes to 4 volts or less, it will be seen that it is necessary to have double the windings on the transformer primary which means a rather large and expensive transformer. It is therefore preferable to use a small auto-transformer to cut down the primary voltage and this has also the advantage that it can be housed in a separate case near the vat at a convenient position for the operator. The rectifier itself may have to be at some little distance from the vat and if the operator has to go to it every time he wishes to make an adjustment, a considerable amount of time may be lost. For rectifiers of 1,000 amperes or more, therefore, separate controllers are usually employed.

The most usual controller consists of 3 rotary switches each having 4 positions, the one giving a coarse control, the second medium and the third fine. By manipulation of these switches it is possible to obtain 63 different settings. This is usually sufficient for most purposes but if a continuous control is required, this can be obtained by a sliding contact working up and down the windings on a coil. These controllers are usually provided with a small hand wheel which operates the sliding switch.

Measuring Instruments

Ammeters.

The ammeter is used for measuring current in a circuit and it is usual to fit one on to each rectifier to see what its total current is. If the rectifier is working on one vat only then this will also record the amount of current flowing through the vat but, in some cases, if the rectifier is feeding more than one vat then it is advisable to have an ammeter measuring the total current and an additional ammeter on each vat showing the current passing through it. The total current can be assessed by adding up the current flowing through each of the ammeters but, on the whole, platers are not very good at arithmetic and if this latter arrangement is employed there is often a danger of the rectifier becoming overloaded.

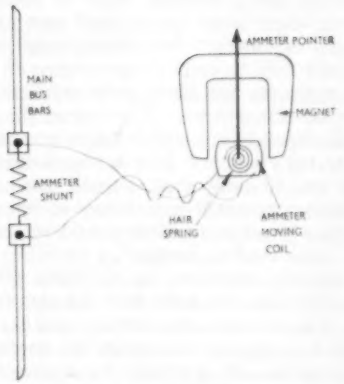


Fig. 1.—Diagram of moving-coil ammeter and shunt

For low-voltage direct current, moving-coil instruments are used. In these there is a fixed permanent magnet and a small coil suspended in the magnetic field. This coil works against a spring and operates a pointer. Since only a small coil is used, it is not possible to put very much current through it and so the instrument is arranged to work on a "shunt," that is to say a low fixed resistance inserted in the main circuit. The current flowing through this resistance produces a small voltage difference across its ends and this again produces a small current which is used to feed the instrument. The whole is calibrated so that it registers the number of amperes flowing through the shunt. The instrument itself can be connected to the shunt by means of flexible leads and thus can be placed some distance away

from it if required. As supplied, the instrument and the shunt will have a serial number which must be the same, and standard leads will also be supplied with it. If these leads are not long enough and longer leads are required, then either the leads must be adjusted to the same resistance to those supplied or, preferably, the instrument must be re-calibrated to the longer leads. Any change in the leads will alter the reading of the instrument. It is also essential that all connexions are clean and tight because since only a very small voltage is generated across the shunt, a very small resistance in the instrument circuit will cause a big difference in reading.

There are many different types of instruments of varying sizes, some being panel mounting and some flush mounting. For plating-shop purposes it is usually best to employ instruments in plastic cases as these are less likely to be attacked by the plating-shop atmosphere. The size of the instrument will depend very largely on its position with respect to the operator. If it is placed somewhere where it can be easily read, a small instrument is quite satisfactory but if it is desired to put it some way away, a larger instrument should be employed so as to make reading simple.

Low-reading ammeters up to about 10 or 20 amperes full scale, generally have the shunts inside the case and are connected directly into the circuit of which it is desired to measure the current.

An ammeter will normally be connected permanently into a circuit. In some cases where very different current ranges are used at different times, it may be desirable to have a multi-range instrument which will be supplied with several shunts covering the different ranges and to provide these with a change-over switch so that the required shunt can be brought into series with the circuit to be measured. The switch can also be arranged to connect the instrument into the shunt in question. Normally, however, an ammeter will be connected permanently into a circuit.

Voltmeters.

It is generally desirable to fit a voltmeter on a vat and it is often also desirable, if a rectifier is feeding more than one vat, to have a voltmeter on the rectifier terminals. The voltmeter in construction is very similar to the ammeter but in this case the coil is in series with a resistance so calibrated that at the highest reading the voltmeter is required to show, it will pass just sufficient current to move the pointer to the extent of scale. A voltmeter, which is connected across a circuit, need not be kept permanently connected and can be arranged with a multiple switch so that when required it can be connected to any of a number of points. Disconnecting the voltmeter does not in any way affect the current flowing in

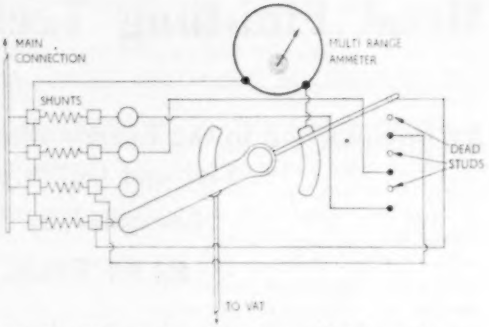


Fig. 2.—Diagram of typical selector switch for multi-range ammeter

the circuit* and it is sometimes desirable to arrange a voltmeter in this way since one instrument can then be made to check a number of vats. However, where a vat is in constant use and particularly with the larger installations it is generally preferable to have a separate instrument on each vat so that the operator can tell at a glance the voltage being supplied.

It is also extremely useful to have a small portable voltmeter which can be quickly connected across any part of the vat circuit. If this is provided with a couple of probes it can be useful for finding bad connexions or to ascertain whether the anodes have become passive. The two probes can be placed one on the anode and the other on the article being plated and the voltage across these two compared with the voltage shown on the rectifier voltmeter. If it is found to be considerably lower this will normally mean that there is some resistance in the circuit and by taking the voltage from the rectifier terminal to the anode or cathode bar it will usually be possible to find out where the trouble lies. On the other hand if a high voltage is found from the anode to the cathode this may be due to the anode having become passive and this may be checked by putting one probe on the anode itself and connecting the other to a piece of wire which is then placed in the plating solution. If it is found that there is a high voltage between the anode and the solution, it is an indication that a passive film has formed on the anode.

Ampere-Hour Meter.

For many purposes it may be desirable to arrange an ampere-hour meter in the circuit. This meter measures the number of ampere-hours which have passed through the circuit, that is to say the amperes multiplied by the time. Since the amount of metal deposit in a plating vat is proportional to the number of ampere-hours it can

*Except where the currents are very small and/or the resistance of the voltmeter is low.

also be made to show the weight of metal deposited or, on a standard article, the thickness.

Many solutions require certain additions to be made to them proportional to the amount of current passed through them. For this purpose the ampere-hour meter is very helpful as it is possible to tell directly from this how much addition agent or metal salt should be added to the solution. If desirable, it is also possible to arrange that the addition is made automatically from this instrument.

Ampere-hour meters are of two main types: one is somewhat similar to the house meter and records the number of ampere-hours which have passed through it since the instrument was originally set. The other is arranged to be set at a given number of ampere-hours and works back to zero.

When it reaches zero it can be arranged to operate a contact which will ring a bell or give any other pre-arranged signal or, if desired, cut off the current. This latter type is generally used where it is necessary to build up a deposit of controlled thickness.

The meter itself takes the form of a small motor operating a train of wheels connected to a number of small pointers. It is again operated from a current tapped from a shunt since the amount of current required to operate it is only quite small. The readings of the meters vary and in purchasing it is necessary to specify exactly what range of meter is required and also what type.

Current-density Meter.

It is often desirable to know the current density of articles being plated, particularly in different parts of the vat where it may vary quite considerably. The most usual meter for this purpose consists of a small cylindrical cathode of known surface connected to an ammeter and arranged to hang on the cathode bar or to be connected to it by means of a flexible wire and clip. This instrument is inserted into the vat and the meter which has been especially calibrated shows the current density in amp. per sq. ft., at the point at which the cathode cylinder is placed.

Other Measuring Instruments.

A number of other electrical instruments are used in the laboratory but are not usually found in plating shops. These include such things as potentiometers, valve voltmeters, resistance bridges, multi-range test instruments, etc. It is not proposed to describe these here.

Control Panels

Where a generator or rectifier is required to work on several vats it may often be necessary to have individual control on each of these. To do this a variable resistance must be inserted in each vat circuit and these resistances must be of sufficient size to carry the vat current which is often considerable.

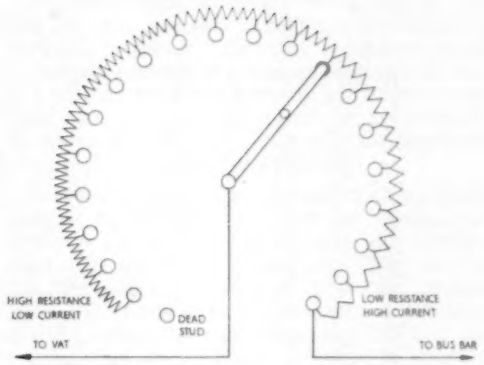
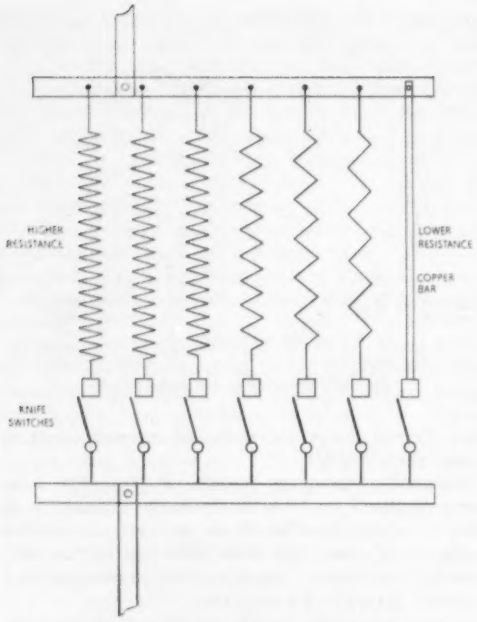


Fig. 3.—Series-type resistance board

Although resistance boards of this type have been designed to carry fairly heavy currents it is very doubtful whether it is advisable to control a current of more than some 200 amp. in this way, and with heavy currents it is usual to arrange for a separate generator for each vat.

These resistance boards are of two main types, series and parallel. The series board is generally provided with a rotary switch which makes contact on a number of studs. A resistance is inserted between each pair of studs and these are usually arranged so that at the one end there is a low resistance capable of carrying a high current and at the other end a high resistance designed to carry only a small current. The resistance at the high-current end of the board is connected to one terminal of the circuit and the blade of the rotary switch to the other. As the switch is gradually rotated, the total resistance of the board is altered and as this is reduced the current increases. By the time the switch has been rotated to the last stud all the resistance is cut out.

This type of resistance gives a moderately straightforward continuous control but is not very suitable for currents over about 50 amperes, since to carry heavy currents it is necessary to have a very heavy rotating switch which is not only expensive but often liable to over-heat. If this happens the switch blades become softened and the apparatus does not work satisfactorily. For heavier currents, therefore, it is generally preferable to use a parallel-type switchboard. In this case a number of resistance coils are arranged in parallel each one controlled by a knife or other suitable type of switch. By bringing in one or more of these coils the total resistance of the board can be altered. When all the switches are out the circuit is broken, while it will have its minimum resistance when all the switches are in. It is usually desirable to



have one switch at the end capable of carrying the total current required and arranged to short-circuit the whole board through a copper strip, otherwise when all the switches are in there will be a certain amount of residual resistance in the board which will produce a voltage drop.

Various modifications and combinations of these switchboards have been used from time to time for special purposes; on the whole, however, control panels of this type are not popular in modern plating shops, it being preferable to use separate rectifiers for smaller vats and to control the current directly through these.

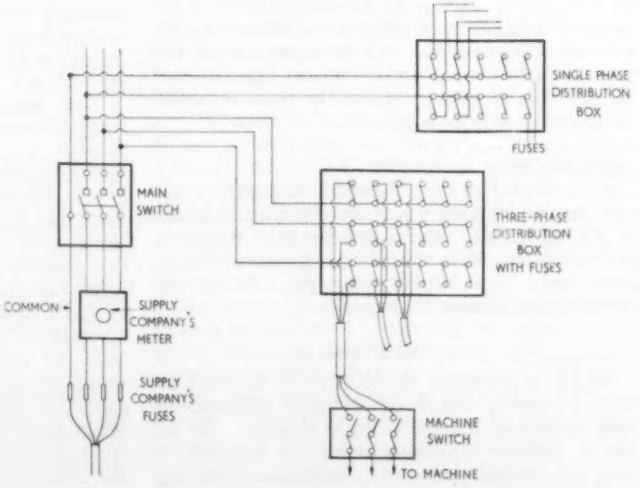
Alternating-current Circuits

Practically all electric current is now supplied as alternating current and therefore it may be assumed that the main supply to a plating shop will be a.c. probably 400 or 440 volts, 3 phase. While the plater is primarily concerned with direct current flowing through his plating circuits, it is advisable for him to know something of the methods used to distribute the mains voltage to various pieces of plant requiring it.

Normally the mains cable will enter the building at some point nearest to the road and will be brought up into the building and terminated in a junction box. This may vary according to the size of the supply but generally there will be one box for each phase and one for the neutral. From this junction box the current will be led through the Company's meter and then into the main switch for the building. This mains switch must be provided by the occupier of the building and the Supply Company will install the meter and wire the circuit into the switch. This part of the circuit belongs to the Company and will be sealed by them and must not be touched by anyone else. From the main switch the current will be led to a number of distribution boxes, depending on the size and complexity of the plant. The 3-phase power circuit requires a box having three sets of fuses. If it is required to have a single-phase circuit this will be taken off one of the phases and the neutral or common terminal which will also normally be wired into the box of the main switch.

Fig. 4. (above)—Parallel-type resistance board

Fig. 5. (right)—Diagram showing three-phase alternating-current wiring with three-phase and single-phase distribution boxes



In a large installation it is usual to take a lead from each of the phases and distribute the load as far as possible over the three circuits so as not to load one phase more than another.

All wiring will be enclosed either in a metal duct or conduit or in some cases a lead or copper-sheathed wire may be used in which case the sheath must be earthed. From the main distribution box, leads are taken to suitable points on the plant where subsidiary distribution boxes may be fitted, and then to the switchgear required to operate the individual machines. Each piece of apparatus must have an isolating switch and a fuse. Even if the apparatus is supplied with a press-button starter and overload coil it is still necessary for it to be fused, and if the particular apparatus is portable, *e.g.* a portable filter pump, it is necessary to have an isolator switch and fuse fixed on the wall and a suitable plug to make contact with the flexible lead of the motor. This lead should have an additional earthing wire so that the motor can be earthed through it.

It is very essential that the plater should follow out the circuits in his shop so that he knows exactly where the fuses for each piece of appratus are situated. Distribution boards should be clearly labelled, as should also the switches controlling them, showing which piece of apparatus is connected to each position on the board, but this is not always done. If a fuse blows, therefore, it may involve a considerable amount of labour to find out exactly where it is situated and there is always the danger of pulling out the wrong fuse and breaking the circuit to another piece of apparatus which can cause trouble.

In dealing with electrical troubles in a plating shop the plater should remember that the floor of the shop is generally wet with a conducting solution. If, therefore, he happens to touch a live terminal he may receive a fairly considerable shock. Also, should a live terminal become connected to the plating circuit the vats and everything around them may become live. The wiring in a plating shop, therefore, should be carefully carried out and all pieces of apparatus should be properly earthed. If any work is to be done on this it is necessary to make certain that the fuses on the circuit are withdrawn before work is started.

Where new wiring is being installed it is desirable to make certain that this is heavy enough, not only to take the present current requirements, but also future loads, which may be higher.

The load on a circuit can be calculated and the carrying capacity of the wire found from tables. This will normally be done by the electrical contractor or firm's electrician but the plater will generally have to specify what apparatus he may require and also to advise on whether it is likely that the requirements will be increased at a future date.

In certain cases, temporary wiring may be used and for this purpose a rubber-coated cable is normally preferable. However, temporary wiring is to be deprecated in a plating shop and as soon as a piece of apparatus is finally located in a particular spot it should be wired up permanently. If temporary wiring is employed the apparatus concerned must be properly earthed.

Rectifiers require to be provided with a suitable isolating switch and fuses. For the 3-phase type a 3-pole switch-fuse will be used, the standard metal-clad type being preferable. These may be mounted either on the wall or on the rectifier itself. If a rectifier is supplied with a controller it will normally have an off-position but it is still necessary to supply it with a switch to isolate it completely from the mains. The same applies to motors, heaters, etc. In certain cases it may be desired to put the control switch some distance from the mechanism which it operates. If this has moving parts, however, it is necessary for a stop button to be provided in close proximity and within sight of the apparatus concerned. If at any time a piece of apparatus is under maintenance the fuses should be removed or, alternatively, a large notice should be hung on the switch pointing out that there are engineers working on it and that no unauthorized person must touch it.

Low-voltage Direct Current

The current produced by the rectifier or generator for operating the plating plant is a low-voltage direct current at a voltage up to 16 volts maximum although in some anodizing plants, up to 50 or 60 volts may be used. This voltage is so low that even by gripping the two bars nothing can be felt and therefore there is no chance of getting an electric shock. However, if the bars are short-circuited a very heavy current will be produced which will produce a considerable quantity of heat ; there is the possibility therefore of a serious burn resulting if a person happens to be holding a piece of metal etc., which causes the short-circuit.

Since the voltage is so low it is also necessary to have a low-resistance circuit, otherwise it will be impossible to obtain the required current. The current, therefore, is usually carried by heavy sections of copper or aluminium. Both flat and round sections are used but for the heavier currents, flat is the most popular. A copper bar af 2 in. x ¼ in. section will carry some 500 amperes. These bars are generally jointed by overlapping the two ends and joining them together with a metal clamp and four screws. Before clamping the ends of the bars they should be thoroughly cleaned and smeared with a very fine coating of vaseline. The

(*Continued in page* 318)

Letter to the Editor

● Accelerating Corrosion

SIR, "Platelayer" remarks in your June issue, a propos the scrapping of ships, that an investigation designed to develop methods of accelerating corrosion would "have the outstanding characteristic of being a complete innovation."

Alas, this is not so, and in my own experience I have encountered at least three cases where it was seriously desired to increase the rate of rusting for practical ends.

The first, a general case, goes back to the bad old days when it was the fashion, since shown to be faulty practice, to remove the millscale from structural steel by weathering. Somebody proposed accelerating the rate at which the millscale was shed by spraying the steelwork at intervals with calcium chloride solution so as to make it rust more rapidly. The results were disastrous, and we rightly hit the proposal on the head.

Strangely enough, had I thought of it at the time, this procedure or something similar might have been a good solution to the second problem, which arose at the end of World War II. This problem was how to get rid of the barbed wire entanglements round our coast as rapidly as possible. The obvious course seemed to be to get them to rot to pieces in record time.

The third authentic, if somewhat gruesome, case concerned an enquiry from a firm who made steel coffins. Apparently it is desirable that the coffin shall disintegrate rapidly in the ground. I advised them to surround it with plenty of common salt.

Yours etc., J. C. Hudson.

British Iron and Steel Research Association,
London, S.W.11.

Metal Finishing Technology

(*Continued from page* 317)

bars are generally arranged on edge and supported in porcelain insulators.

The average electrical contractor is not very good at installing this type of apparatus because the technique of working the bars is quite different from that of ordinary a.c. wiring. For heavy currents several bars are used in parallel or, of course, larger bars can be employed. Aluminium is generally preferred because it is light and somewhat cheaper to install. The bars should be kept as short as possible and if long runs are required it may be necessary to increase the cross-sectional area. For short runs, 1 sq. in. of cross-sectional area will carry 1000 amp. but for longer runs it is advisable to work on about 900 amp. or even less if the run is more than about 15 ft.

Special cast fittings are normally employed to make contact on to the vat rods. Where contact is to be made on to a moving rod, *e.g.* where cathode agitation is being employed, flexible copper braiding should be used. For wiring up smaller vats a round copper rod may be employed, sweated into the suitable cast terminals.

The vat bars are generally made of a thick-walled brass tube but in some cases, particularly with those processes requiring high current density, a solid copper rod may be employed.

The bar should be supported at various points so that it is rigidly held and the contacts may be checked with a voltmeter when the maximum current is flowing to ensure that there is no voltage drop produced across them. If a bad contact develops this will normally heat and so by carefully touching the rods with a finger an operator may quickly locate any trouble. Such a contact when it heats, generally tends to oxydize and so make a worse contact and, in fact, it may even start to smoke which will very soon call attention to the fact that something is wrong.

It is perhaps worth noting that if short-circuits develop in the plant, they will often produce a characteristic smell usually of burning rubber. If such a smell is noticed at any time the plater should immediately check the cause. (*To be continued*)

ZINC PLATING STEEL SHELL CASES

SINCE publishing the above article, in our July 1960, issue, the author has informed us that the Process sequence has been slightly modified and is now as follows :—

(1) Anodic alkaline treatment in Efcolene, 160-180°F. 1 minute 49 seconds. Current density 50 amp. per sq. ft. on both the inside and the outside of the cases. Air agitation.
(2) Cold rinse.
(3) Cold rinse.
(4) Mouth pickle. Sulphuric acid solution, 16 per cent by volume. 150°F., 4 minutes 13 seconds. Air agitated.
(5) Body pickle in sulphuric acid solution, 16 per cent by volume. Temperature 150°F. Time 3 minutes. Air agitated.
(6) Cold rinse.
(7) Cold rinse.
(8) Anodic alkaline treatment as for Step (1), 1 minute 49 seconds.
(9) Cold rinse.
(10) Acid dip in sulphuric acid solution, 10 per cent by volume. Room temperature. Time 37 seconds. Air agitated.
(11) Cold rinse.
(12) Cold rinse.
(13) Zinc plate, 85°F. 11 minutes 25 seconds. Air agitated. External current density 45 amp. per sq. ft. Internal current density 35 amp. per sq. ft.
(14) Drain.
(15) Cold rinse.
(16) Cold rinse.
(17) Cold rinse.
(18) Passivate. 37 seconds. Using modified Specification No. D.T.D. 923 solution. Air agitated.
(19) Cold rinse.
(20) Cold rinse.
(21) Warm rinse, followed by a drying operation.

Metalizing Steel Wires

(*Continued from page* 312)

however, also removes some alloying elements, such as sodium for instance, which must then again be supplemented. The use of a bath alloyed with silicon did not present any difficulties. From this bath good, flexible coatings are obtained with a long life, 150 per cent greater than with a coating of zinc of the same thickness, and suitable for the production of wire netting and barbed wire.

A further important factor, which has an influence on the flexibility of aluminized wire, is the mutual ratio of the thickness of the alloy phase to that of the coating itself. The nearer the thickness of the alloy phase approaches the thickness of the coating, the worse will be the flexibility and vice versa. The greatest flexibility is obtained from the wire, when the aluminium coating is about 5 times as thick as the alloy layer.

It was established that the diameter of the wire likewise has an influence on the flexibility. Coatings on thin wires are more flexible than coatings on heavy-gauge wires. It has not so far proved possible, however, to establish the mutual effect of these parameters.

In general it may be considered that the best qualities (*i.e.* flexibility and anti-corrosion properties) of aluminized wire may be obtained only by maintaining definite essential conditions, such as the temperature of the bath, the time of immersion, cooling etc. In general it is obvious, for example, that following a change in the composition of the bath, there will automatically be a change in the remaining parameters. Likewise a change in the diameter of the wire has a fundamental effect on the mutual relationship of the individual parameters. It is therefore clear that the maintenance of the technical working conditions is a primary requirement for coating with aluminium by immersion, and must be far more rigorous than during hot-dip galvanizing.

From what has been presented above, it follows also that a production line for metallization with aluminium must be carefully designed, so that all influences are eliminated which could, for instance, cause vibration or a jerky movement of the wire during its passage through the bath. This, for example, gives rise to incorrect draining of the aluminium from the wire, rupture of the oxide films, which has an effect on appearance etc.

Conclusion

Metallizing by immersion in zinc and aluminium are very analogous processes. From the economic aspect the production methods are equal in cost, even although for metallization with aluminium somewhat greater capital costs must be taken into account. In general it may be considered that aluminium is cheaper, and has better anti-corrosion properties than zinc. Aluminium-coated wire, however, is annealed during the course of metallization, and in the event that a material of greater tensile strength is required, it must again be drawn, which has not yet been solved as it has been for galvanized material. In instances where annealed wire is required, coating with zinc by immersion is economically very advantageous, since annealing and metallization can be combined in one single process. The technical features of coating with aluminium by immersion make possible aluminizing of steel wires with a high content of carbon even at temperatures above the critical limit, and also rapid cooling of the wire on emerging from the bath. It is therefore possible to suppose that under definite circumstances coating of wires with aluminium by immersion is economically far more efficient than galvanizing.

Coating of steel wires by immersion in aluminium has not hitherto been introduced in Czechoslovakia on an industrial scale, even although various methods have been worked out which are suitable for production. This is a series omission, since in other states this method of metallization is being developed rapidly, and wire coated with aluminium is banishing galvanized wire from use, due to its better anti-corrosion properties and greater life in service.

Literature References

(1) Australian Patent No. 153,802.
(2) Czechoslovak Patent No. 88,798.
(3) Czechoslovak Patent No. 88,472.
(4) Sprowl, J. D. Hot Dip Wire Aluminizing Processes and Alloys. *Wire and Wire Products*, 1956, October.
(5) Kopec R., et al. Heat Treatments of the Surfade of Metals (Tepelné úpravy povrchu kovů), Státní Nakladatelstvi Technické Literatury, Prague, 1959, pp. 113-118.
(6) Gittings, D. O., Rowland, D. H. Effect of Bath Composition on Aluminium Coatings on Steel. *Transactions of the ASTM*, 1951. **43**, pp. 587-610.

Sixth International Conference on Hot Dip Galvanizing

THE sixth in the series of International Conferences on Hot Dip Galvanizing is to be held in Switzerland–at the Kursaal, Interlaken–from June 4-9, 1961 and not in France as previously announced.

Three days will be devoted to technical sessions at which over 20 papers will be presented on works practice, the properties and corrosion resistance of galvanized coatings, the welding of galvanized steel, the metallurgy of galvanizing, after-treatments, and the heating of galvanizing baths. One session will also be devoted to sheet galvanizing. Works visits will be arranged to general galvanizing plants in Switzerland and to sheet, wire and tube galvanizing plants in Italy. Galvanizing plant, equipment and materials will also be exhibited by manufacturers. The edited proceedings of the Conference, to be published towards the end of 1961, will be issued free to all delegates. Those wishing to attend the Conference as delegates or to participate in the exhibition of plant, equipment and materials should write to the Zinc Development Association, 34 Berkeley Square, London, W.1.

THE METAL FINISHING CONFERENCE

SCARBOROUGH, APRIL 27 to 29, 1960

A Report of the Annual Conference of the INSTITUTE OF METAL FINISHING

(*Concluded from page* 289, *July*, 1960)

ABSTRACT NO. 12

THE ECONOMIC ADVANTAGES OF A SOUND PAINTING SCHEME

by U. R. Evans *

ARGUMENTS similar to those advanced by Blom in 1934 suggest that it would be remunerative to use much more costly paints today if it were certain that their use would prolong the period between repaintings by one year. Objective comparative evaluation is required to ensure that the increase is possible and the need has been filled by independent tests such as those carried out by Hudson, for the British Iron and Steel Association. The tests do not comprise all paints, but they give disinterested information over a field wider than anything covered before and include also protection by inorganic coatings, notably metallic coats obtained by spraying, hot-dipping or electroplating.

Different causes of premature breakdown are considered in turn ; clearly if these can be avoided the period between repaintings can be increased and the annual maintenance cost reduced. Alkaline softening and peeling, met with under marine conditions, are characteristic of oil paints. Mayne, analyzing the results of Fancutt and Hudson who had studied 127 paints in sea water, pointed out that protection was associated with the alkali resistance of the vehicle. The objection to using paints containing saponifiable vehicles in marine paints, has become very evident since cathodic protection has come into use for ships, since such paints fail entirely when the ship as a whole is made cathodic. This has encouraged the use of alkali-resistant paints for marine work generally. It would seem that the benefit of cathodic protection is not confined to those ships where it is applied but also extends to ships where it is not applied, since there is now an increased chance of such ships receiving a paint appropriate to marine conditions.

In contrast, oil paints provide excellent protection on land, owing to the inhibitive powers of certain products of degeneration of soaps present in such paints. Such products are more soluble than the original soaps and have been proved to possess inhibitive properties ; they include the lead salts of the dibasic azelaic acid and of an unsaturated hydroxyacid related to pelargonic. This has suggested that an inhibitive paint might be prepared by adding such salts to a paint pigmented with a non-inhibitive pigment, such as common red iron oxide.

Protection at gaps in coatings is obtainable by using metal-pigmented paints, but gap protection may disappear when a second coating is applied upon the metal-pigmented paint for decorative purposes.

The presence of salts, especially ferrous sulphate, in rust trapped under paint is an important cause of the humping up of paint by voluminous rust formed at the sites of nests of salt, with subsequent breakdown of the coating.

If the salt is on a bright surface, it is easily washed off, and, if the surface can be rapidly dried, the problem presents no difficulty. However, salts deeply buried in old rust are not easy to remove by washing. In such a case complete removal of the rust by grit-blasting or grinding may be the best procedure. In manufactured articles, it is advisable to apply the paint as soon as the surface has been cleaned mechanically. If articles must be stored before painting, the air in the storeroom or cupboards should receive attention.

If it is decided to remove rust and scale by pickling, great care is necessary to wash acid residues from crannies, otherwise they will produce ferrous salts, with unfortunate effects.

One advantage of the Footner duplex pickling process, in which treatment in warm sulphuric acid is followed by a short dip in hot phosphoric acid, is that any ferrous salt left behind will be

* Emertis Reader in The Science of Metallic Corrosion, University of Cambridge.

phosphated. In manufacture today, a proprietary phosphating treatment often follows pickling: this confers several benefits, such as conversion of the most sensitive points on the steel to a harmless compound, the provision of an extra protective layer and a good keying of the paint or protective grease. It seems that the fact that ferrous chloride or sulphate could probably not long exist in contact with zinc or manganese phosphate may be an advantage, hitherto little appreciated.

The question of special paints for application over rust is arousing interest. Salt-free rust presents comparatively little difficulty. It is the presence of electrolytes which constitute the problem.

In conclusion the author says that the mean annual maintenance costs can be reduced if the interpainting interval can be increased, and this means avoiding the various types of breakdown already mentioned:

1) Alkaline softening and peeling of coats.
2) Rusting at gaps and lateral extension from them, particularly below mill scale.
3) Humping up of the coats at the sites of salt nests.
4) Gas blistering.

Some of these troubles can be avoided by suitable preparation of the surfaces and correct choice of paints. For some situations where the right paint does not exist today, there is good hope that the proper application of our understanding of the electro-chemical mechanism of corrosion may produce it in the not too distant future.

DISCUSSION

Mr. S. C. Britton (Tin Research Institute) said that Dr. Evans had been speaking and writing on the main theme of his present paper for a great many years and had reinforced his arguments with some up-to-date and interesting experiments, but it might be useful to inquire why it was necessary to keep on saying the same thing in order to encourage people to make a large investment in initial protection.

There were two main divisions of the problem: (i) when the firm was protecting its own equipment, and (ii) when the material was being protected for ultimate sale. Where goods were to be offered for sale the problem was difficult, because the customer was largely ignorant of the protective processes which had been applied to the goods. Most buyers of metal goods had a trust which went about as far as the performance of the worst quality that had come within their experience and observation, and Gresham's Law applied to consumer goods generally, in that the worst became the standard. It might be advisable to preach to some of the new consumer protection associations on this matter; there might be scope in the future for extensions of the scheme such as the Mond Nickel Company was endeavouring to attach to nickel plating. Protective finishes generally could well be studied very much more by consumer protection associations and testing houses, and, in so far as they genuinely carried out tests, they should be helped and encouraged and provided with methods of test.

The problem of the firm protecting its own equipment should be easier, because the whole matter was in the hands of one group of people; but there was always a strong resistance towards investment for long-term benefits, and when a Government tried to take some measures for long-term benefits such measures were always stigmatised as unpopular, and they were in fact unpopular. Lord Kaynes had said "In the long run we are all dead." If we were not dead we had retired or gone to another job and people did not like investing money for benefits which might accrue only to their successors. To help this situation steps should be taken to see that the benefits which were sought were certain and were seen to be certain. Some people had been disappointed because when improved methods were applied to give generally better protection it might be overlooked that there were special places on a structure or vehicle which were not well protected by those general protective measures. An example was the window edges on vehicles. There were special points, as in joints, which particularly required study, and areas subject to damage in installation, and plant which had received its preliminary protective treatment in the works might be left lying on a site, perhaps prior to ultimate erection.

With regard to that last point, the gap protective paints might have considerable application. The author might be expecting a little too much from them in regarding them as general-purpose primers. Mr. Britton thought that particularly those paints based on inhibitive materials derived from oils and metal soaps might find a better place as pre-treatment primers to protect metal when it was most likely to be damaged and had no undercoat to inhibit the protection of the gap. In general much more attention should be paid to the application of protection to special areas, areas exposed to damage, to the collection of rainwater or other corrosive materials, and joints where welding flux and other things might cause trouble. The object should be like that of building the wonderful "one horse shay" about which Oliver Wendall Holmes wrote, in which each part was built to last 100 years and they all collapsed together.

Great care was necessary in persuading people to spend more money on protection not to give any encouragement to the idea of any conditional exemption from protective treatments. That brought him to the experimental part of the paper.

The author's demonstration of the way in which included salts led to a continuing expansion of the rust was most welcome, but, accepting that explanation, it seemed that any electrolyte trapped in the rust would cause this continual swelling of the rust. That being so, it was a grave error to encourage the belief at the moment that it was going to be possible to paint over rust with the existing paints, and that there were today safe rusts and unsafe rusts. The author did not directly say that, but in referring to the work of Dr. Mayne he gave a little loophole of encouragement.

Dr. Mayne in his original paper had been very careful to say that the results which he had obtained had been only on one site and that very careful investigation would be required elsewhere. Dr. Evans stated that satisfactory results, as good as those obtained by painting on unrusted steel, had been obtained when the Cambridge spring rains had washed the sulphate out of the rust. That might be so, but what happened to the parts which the Cambridge spring rains did not wash over—the concealed portions and so on? People must not be encouraged to paint over that. Perhaps the author would comment further on this and make it clear that a stage had not been reached when people could be told that they could paint over a "safe rust." Mr. Britton had already seen abstracts of Dr. Mayne's paper in the technical press which would encourage people to think that it would soon be possible to say "paint on midsummer's day and all will be well." The next stage would be that people would be offered bottles of Cambridge spring water "as recommended by Dr. U. R. Evans, F.R.S.," as the specific for washing rust.

Zinc-rich Paints

Dr. F. A. Champion (British Aluminium Co. Ltd.) referred to the zinc-rich paints which he had first tried without thinking anything about the electrochemistry of steel and with which he had obtained excellent results for about two years and said that after that time blisters started to appear. That caused him to give some thought to the matter and it seemed natural that if cathodic protection was used it would mean generating hydrogen within the paint film and getting blisters. He had recently done some work on those paints as anti-fouling paints on aluminium, and obtained the same effects with them.

Dr. A. Kutzelnigg (Siemens-Schuckertwerke, Nurnberg) said the author had mentioned the cathodic protection given by zinc-rich paints in sea water and had also pointed out that the gap protection vanished if a nearly non-porous coating was applied on the zinc-containing primer. Dr. Kutzelnigg wished to refer not to the behaviour of zinc-rich paint in sea water but to its behaviour in industrial and marine atmospheres. In this respect it had been found that zinc-rich paints without top coats were of little practical use; on the other hand systems with top coats had never shown any signs of cathodic protection. That agreed well with the findings of the present author.

Two papers recently published in Germany made it doubtful whether cathodic protection was of the first importance, even in the case of primers alone. *D'Ans* and *Schuster* had shown what was the essential role of basic zinc salts formed by the corrosion; these products were said to cement and seal the particles of zinc powder. *Ladeburg* had investigated the conductivity of the zinc-rich paint films and had found it to be extremely small; he could not establish any correlation between the conductivity values and the protection given by the primer. It was also Ladeburg's opinion that the products of zinc corrosion were of prime importance.

The idea of cathodic protection by paint had been over-emphasized in the past by trade interests. More work was clearly needed to establish to what extent electrolytic protection helped in the performance of zinc-rich paints.

Mr. C. D. S. Bridgett (R.E.M.E., War Department), confessed to having had a little difficulty in reading the paper, due, he thought, to the fact that its title was a misnomer. The paper did not in fact deal with economics at all, but there was a great deal of valuable information in it. He wondered whether the author had ever come across people who thought that the only difference between a good and a bad paint was that a good paint could be applied by an ordinary man, while a bad one required a skilled person to obtain the same result? Mr. Bridgett thought that 90 per cent of the money wasted on painting in this country was wasted in bad preparation of the paint in the shop and bad application. He had something like 150 workshops to cover, and that was his experience. Mr. Britton had mentioned vehicles. Mr. Bridgett had been asked twelve months ago to examine some new commercial vehicles bought off the shelf for the Army, and to examine the paint. He had gone underneath the vehicles but had failed to find any paint at all, which had given him a very poor idea of the motor industry in this country.

Cleaning After Assembly

There was one point on which he disagreed with the author. He recommended the cleaning and de-rusting of structures after assembly. Mr. Bridgett believed that that was wrong and did not think it could be done cheaply. He could not imagine how a structure such as a bridge would be grit-blasted; even vacuum blasting was

expensive. There was a piece of equipment in the Army bought in 1948 and it had been overhauled periodically in storage but never used. The overhauling had now cost more than the original cost, because in the structure there were members put together with rust in between, and when rust got in it was never possible to stop it by painting over. He always insisted on joints being primed or filled with a jointing compound. He believed that all good steel erectors primed their joints before they did them.

Etch Primers

The author's conclusions on the last page of his paper Mr. Bridgett found perturbing. It was easy to accept the first part of them, but when the author referred to " The wrong selection of paint—or application of the right paint to the wrong surface " had he in mind that the old idea of inhibited primer followed by an undercoat and a top coat was wrong? Also what were his views on the use of etch primers as a pre-treatment? Had he tried calcium plumbate paints? Mr. Bridgett had been told that these did not operate unless they were put on rust. Had the author heard of the fire spray method investigated by the Germans just before the war? A German railway bridge had been sprayed by that method in 1935, and even in 1945 had been as good as new. A dock gate had been dealt with in the same way and found to have suffered no damage. It had been claimed that a life of twenty years or more was obtained from that paint.

Dr. T. P. Hoar (University of Cambridge) expressed regret at not being able to reply to Mr. Bridgett in some detail. Possibly Mr. Bridgett did not know how to shot-blast or grit-blast a bridge, but it had been done and in the case of the Jubilee Bridge at Barrow it had been done many years ago.

The paper interested him from many points of view. First of all, the removal of salt from any structure which was painted had long been understood to be a good thing, and the author had rendered a service by again emphasizing this. The mechanism by which the author had very elegantly shown the formation first of magnetite and then of red rust, with then a reduction back to FeO.OH through the presence of an electrolytic medium was a very important feature of the paper. When it was demonstrated, as in this case, what the actual way was in which particles of salt or sulphate operated in a paint film, people would be able to take the general conclusion that salt should not be dropped on paint films much more seriously, now that there was the electrochemical demonstration which the author had given. The electrochemical reduction of FeO.OH was akin to the electrochemical reduction of NiO.OH in the alkaline nickel accumulator, where nickelous hydroxide was formed, but in the present case ferrous hydroxide was not formed because it was unstable compared with iron and magnetite.

The next service done by the author was to emphasize again that the medium of the paint was at least as important as the pigment. People were inclined to refer to iron oxide paints, red lead primers and so on without referring to the medium. In marine conditions it had been shown that bridges were still being painted with the use of media which were not particularly alkaline resistant. For marine conditions it was necessary to use phenolic-type paints, and possibly some of the newer synthetics would prove to be even better.

Dr. Hoar disagreed a little with the way in which one of the statements in the paper was put. It would appear from the paragraph headed " Tests by disinterested bodies " as though all was well in the field of testing various types of paint systems on various surfaces, because of the work done by Dr. Hudson and his colleagues at BISRA. Unfortunately, that gave the impression that all this work had been done, but no-one would be more ready than Dr. Hudson to agree that it had not been done. There were very few full-scale tests on steel coated with a primer, coated with an undercoat and coated with top coats that had been done by completely disinterested bodies such as BISRA. There had been even fewer tests done on zinc-sprayed or aluminium-sprayed steel followed by a complete painting scheme. Because of the lack of actual factural experimental knowledge in this field, it was still necessary to design and recommend coatings for bridges and the like which were based not upon experiment but upon armchair theorizing. This was, he believed, about to be put right and tests were about to be done, but at least twenty years too late, and it would not be possible for another five years to say whether it was better to use zinc spray rather than aluminium spray in a paint scheme, and so on. It was to be hoped that the work which Dr. Hudson was now going to undertake would be assisted as much as possible by all those interested in and concerned with metal finishing.

The author had somewhat wistfully said that it seemed a pity that theories established 25 years had been used so little in practice. That was too pessimistic a view. Dr. Hoar had made a list of a few of the practical corrosion-prevention methods which were nowadays taken, all of which depended for their correct application on at any rate a reasonable knowledge of corrosion theory as it had been established in the 1920's and 1930's.

First of all, in regard to cathodic protection, cathodic protection engineers would not be able to carry on their work without a fundamental knowledge of how cathodic protection operated. That

had been one of the earliest subjects to be studied at Cambridge and other laboratories from a more or less theoretical point of view.

Second, the composite type of coating had been mentioned. It would not be possible to recommend or suggest composite metal-cum-paint coatings today on the basis of experiment and it was necessary to rely entirely, or at any rate very largely, upon theories of the formation of alkalis from salts, of the currents of anodes and cathodes at different parts of the surface, which was a practical use of corrosion theory.

Stress-corrosion Cracking

Third, they were just beginning to understand something about stress corrosion cracking and how to prevent it. That work could not have even begun without a considerable knowledge of corrosion theory of what the author would probably call the classical kind. The use of inhibitors was another matter largely started by people working in laboratories but which was now a large industry. The passivation of zinc and cadmium coatings arose almost directly from early studies of passivation done in laboratories. The galvanic two-metal attack of which most engineers today were conscious, even if they did not quite understand it, owed a great deal for its avoidance to a knowledge of anodes and cathodes and electro-chemical theory. The removal of salt from material which was to receive a protective coating was also an important matter, and in that connexion it might be of interest to mention that talking to a Conference member about the protection of a marine installation where it was necessary to remove the old rust and put on a thick protective coating during the five hours available between tides, the method it was proposed to adopt was to grit-blast the structure and slap on a thick coat of a proprietary organic finish, but no consideration had been given to the question of whether or not it would be desirable to get rid of salt from the old rust in the old plate. Dr. Hoar had said that after the grit blasting there was bound to be salt on the surface and that a wash down with clean water would be highly advantageous. So impressed was the member by this that he had left Scarborough at the cost of missing the dinner that evening and gone away to see this washing down with fresh water. That represented a very rapid translation of theory into practice.

Author's Reply

Dr. Ulick R. Evans, in reply, expressed agreement with almost everything that Mr. Britton had said. It would be a good idea to bring in the consumer protection associations, because they were the people who ought to deal with this matter or who at any rate should be encouraged to take it up. He agreed also that long-term measures were unpopular, but it was a good thing sometimes to force home unpopular measures. There was only one point on which he felt that Mr. Britton was a little pessimistic, and that was in the statement that it would not be possible for a long time to get a paint which would go over rust containing salts. There was in fact good evidence that different salts behaved differently and some were better than others, and it was not merely a question of conductivity. It was therefore possible to formulate paints to take advantage of this fact and turn a harmful salt into a relatively harmless one. He thought that there was evidence among the specimens exhibited at the Conference that that was possible, because it was a question of comparing paints with certain additives which had normally improved the situation, and it depended on that sort of principle. He agreed that it would not be possible to rely on the spring rains to do the trick. Dr. Mayne had himself felt this and had done some experiments in trying to wash out the harmful salts and had found that for the thicker rusts, which were obtained after many years of exposure, it was necessary to wash them a very long time. He regarded that as impracticable, in Dr. Evans's view rightly. They had to some extent studied the effect of rusting for different times, and had found it was more difficult to wash out salts from below a thick rust layer than from below a thin one, but after a certain thickness of rust had been reached, if the salts were left behind they became less dangerous, though he would not say that they were harmless.

In reply to Dr. Champion he agreed that there was trouble with blistering. At one time he had thought that it was being overcome, but now he was no longer sure of that. They were beginning to get an understanding of how it occurred, however, and Dr. Champion had given the explanation, and it was not impossible that the difficulty would be overcome. Dr. Evans had not personally come across it on aluminium, but was not surprised that it occurred. He thought it might be rather more difficult with aluminium than with steel. He had been particularly glad to have the contribution from Dr. Kutzelnigg. With regard to what Dr. Kutzelnigg said about zinc-rich paints, Dr. Evans agreed so far as the unimproved ones were concerned but was not without hope that some of the improved ones would give worthwhile protection in industrial districts. In fact the specimen shown in the exhibition held in connexion with the Conference provided some evidence that by using a porous paint on the top of a zinc-rich paint it was possible to obtain what was undoubtedly cathodic protection at gaps.

Dr. Kutzelnigg had expressed doubts about whether the protection obtained at gaps was due

to cathodic protection or not, and the same doubt had been expressed with regard to metal spray coatings. Dr. Evans felt he could say with some confidence that it was due to cathodic protection. It had been suggested that it was due to the blocking up of holes by corrosion products and with very narrow holes with a cross-section which was small compared to the thickness of the coat such blocking was quite important. On the other hand, he had obtained protection both with paints and with sprayed coatings where the gap had been very broad compared with the thickness of paint and there had been no question of blocking it up with corrosion products or anything else. He had ascertained the current passing between a bare steel specimen and another steel specimen coated with whatever had been used—sprayed zinc or zinc-rich paint, for instance—and had found that worthwhile currents passed between the two. The currents had been measured and the e.m.f. had been measured. If the zinc content was reduced by adding, say, zinc oxide, keeping the vehicle the same, the e.m.f. was almost unchanged, although the current, of course, was reduced.

A good many statements had been made about the low conductivity of zinc-rich paints, but he was never sure whether the reference was to electronic conductivity or electrolytic conductivity, and both could come in in different ways, but he was not unduly pessimistic about points of the kind which had been raised in a very useful form by Dr. Kutzelnigg.

Some of the points raised by Mr. Bridgett had been dealt with by Dr. Hoar, and Dr. Evans supported the examples which Dr. Hoar had given. What he said would also serve as a reply to the inquiry about what he had really meant in talking about the application of the right paint to the wrong surface costing too much money. Oil paints were admirable for protection in inland conditions, on account of the inhibitive degradation products which had been isolated by Dr. Mayne and others, but they were quite unsuitable for most marine conditions, and if used, for marine conditions were an example of the right paint being used for the wrong conditions. As had been pointed out by Dr. Hudson and Mr. Fancutt, even a very good paint would give bad results if applied to a bad surface. The right preparation of the surface was very important. The difference between a good and a bad paint was not so much that the bad paint needed a good craftsman to apply it, but rather that if the surface was bad and the paint was good even the very best painter would get bad results, while on the other hand a comparatively poor paint, applied even by a not very skilled person, if applied to a well-prepared surface would often give surprisingly good results, as Dr. Hudson had said.

Dr. Evans fully agreed that joints must be protected before they were brought together, and that had been appreciated for almost as long as he could remember. He seemed to remember recalling that statement at the time when he had written his first book on corrosion, having found it in a book which even at that time was very old, written by a practical engineer. The author had written two books, one of which was called "Scamping Tricks," and would be well worth republishing.

He had understood Mr. Bridgett to say that the manufacturers said that calcium plumbate did not operate unless put on rust. Dr. Evans thought that in that case they were pessimistic, and that the matter ought to be taken up with them.

He was particularly grateful to Dr. Hoar for having dealt with so many of the points raised by Mr. Bridgett. Dr. Evans agreed that vehicles were quite as important as pigments. The removal of salts was very important, and a structure could be saved by following the advice which Dr. Hoar had given. Dr. Hoar suggested that it was pessimistic to express the opinion that no practical use had been made of the understanding obtained of the electrochemical mechanism of corrosion. In making that suggestion Dr. Evans had been referring to the formulation of paints ; he agreed that the knowledge available had been used in other connexions and that some of the examples given by Dr. Hoar were pertinent, but, apart from composite coatings, they all referred to other matters than paints. He also agreed that Dr. Hudson's programme of tests had not gone nearly far enough, as Dr. Hudson himself would certainly agree. Dr. Hudson and others had worked very hard, and, although Dr. Evans could have wished that some things had been left out of the programme and others put in, it was difficult to please everyone. The particular case mentioned, the research for the best paints to go over spray coatings, was an example of research which he would have liked to see started a long time ago. Mr. Britton when in Cambridge obtained some admirable results in inland conditions, but the question of paints for marine conditions on sprayed coatings had not been gone into very much.

Abstract No. 13

WATER THINNED COATINGS IN INDUSTRIAL FINISHES

by E. L. Farrow *

TODAY the major interest of paint manufacturers is the development of water-thinned paints for industrial finishing systems, because of the number of advantages such materials have to offer. Solvent is employed in the manufacture

* British Paints Ltd.

PERSONALITIES at the CONFERENCE

Fig. 1—Left to right. Standing: J. W. Weaver (Asst. General Sales Manager, Harshaw Chemicals Ltd): E. H. St. Clair Moorey, (Plating and Process Chemist, Vauxhall Motors Ltd): F. Enrico, (Laboratori Ricerche E. Controlli, Auto-Avio, Italy): R. T. F. MacManus, Seated: Mrs. E. Blewitt and Mrs. A. C. Benning.

of paint to enable the user to apply it in the easiest manner. If therefore a cheap and abundant solvent such as water can be used, appreciable economies can be made.

The main advantages offered by the use of water-thinned paints include :—

1) non-inflammability.
2) freedom from odour.
3) cheapness and availability
4) faster production times.

There are however a number of disadvantages and perhaps the principle one so far as the finisher is concerned, is the expense of alteration in plant lay-out which would be necessary to make the best use of these systems.

The paper goes on to explain the types of water-thinned paints, and states that it should be possible to disperse in water almost all of the high polymer organic binders in common use today. There are two main types of water-thinned media available :

1) media that have been dispersed in water ; the latex emulsion types.

2) media which are soluble in water.

The water-dispersed types include polymers which may or may not harden during the stoving operation.

The flow characteristics are not good, due probably to the marked change in consistency of the film when the water has evaporated, but a means to overcome this defect has been found. There is also a tendency for paints based on dispersion media to foam during agitation and care must be taken in the choice of the anti-foaming agent.

Water-soluble media exist as clear liquids which remain clear and in phase when diluted with water. In these types the film former must contain a sufficient number of hydrophilic groups to render the bulk soluble in weak aquaeous solutions, and can be achieved by introducing carboxyl groups into drying oil systems, for example, by maleinization to cause the product to dissolve in dilute aquaeous ammonia.

Materials which are available at the present time include water-thinned coatings for sealing castings, red oxide car-body primers and primer-surfacers and white or off-white domestic-appliance primers. Gloss finishing systems are under active development but it may be some time before good paints become available, bearing in mind the necessity for full-scale evaluation and durability testing under outdoor conditions.

The water-thinned casting sealers are designed for use on exterior or interior surfaces of castings where oil resistance is usually required. The coating may also be used as a rust-preventative treatment for unmachined castings during storage. The difficulties to be overcome in the formulation of good casting sealers include rust staining and cracking of the film when thick coatings are applied. Rust staining may be overcome by the addition of a suitable inhibitor, and cracking has been overcome by using a mixture of water-thined media.

Car-body primers and primer surfacers provide a good field in which water-thinned coatings may be used. There is no difficulty in the application on phosphated metal surfaces but on mild steel many such primers, especially the dispersion types, give rise to rust stain unless they contain small quantities of inhibitor.

These systems may be applied by the standard methods of brushing, spraying, dipping and flow coating. With dip applications the biggest problem is the control of foam in the dip tank. Hot spraying of primer surfacers is highly recommended, in the paper, in order to achieve maximum film thickness in a single application of paint, while " wet-on-wet " techniques may be used provided some flash-off period is allowed.

In conclusion, it can be seen that some progress has undoubtedly been made during the last few years in the development of water-thinned coatings for industrial finishing systems. There are, as yet, no substantial cost savings on the paints themselves but it is certain that once these systems are established in the finishing plant there will be some reduction in the cost per unit treated.

Only a limited practical experience has been obtained so far but it has promoted some large scale finishing shops to modify their plant layout and to use water-thinned primers and primer surfacers. Finishing paints are still in the final development stage and it will not be long before water-based industrial coatings become available. When this occurs, fire hazards will be virtually eliminated and working conditions should be much improved.

DISCUSSION

MR. E. S. FRY said that water-thinned finishes for industrial use had been discussed at intervals for the last six years or more, but the subject was one on which the paint industry and users were a little in the dark so far as the end uses were concerned and what the market was going to be. Extremely optimistic statements had been made on the other side of the Atlantic about motor cars in the next ten years being finished in water-thinned materials. He was inclined to agree with the author that some caution was necessary in that respect, but if the paper led to the point of view of the user being expressed it would be of great value. The author mentioned that re-equipment for water-thinned paints might be an important factor. One could see that this might be an important point for closely integrated production lines, and there it might be a question of introducing them when designing new equipment. If that were done there would potentially be great savings in fire-fighting equipment, insurance premiums and so on.

On the question of atomization of spraying, under the heading " Car-body primers and primer-surfaces " the author said " In spray applications the lower surface tension of water-thinned systems gives a greater degree of atomization and paints can therefore be sprayed at much higher consistencies than normal solvent-thinned paints." Mr. Fry agreed with that up to a point, but thought that it needed qualifying, because on the face of it by using water, which had a much higher surface tension than any other liquid used as a solvent, one would seem to be putting oneself at a considerable disadvantage ; its surface tension was about 72, whereas figures of 30 to 40 were more usual. Perhaps the author referred only to emulsion or dispersion types in which there was always a much larger surface tension because of the large amount of surface activation which must be present in any event. In the case of some water-soluble resins the surface tension presented some difficulty, because it was on the high side and one did not wish to spoil things by adding some surface-active agent.

Stoving Conditions

With regard to stoving conditions, Mr. Fry supported the statement that some care had to be taken. Water was an awkward character in some ways ; not only did it come off more slowly but its boiling point was 20 to 30 deg. lower than the average stoving temperature, and, even if some precautions were taken to get rid of it, the little which was present would boil very rapidly. On the other hand, if a plant was designed with multi-stage temperature of the oven, it was possible to get over this difficulty very easily without adding much to existing time schedules.

Under the heading of " Performance " the author mentioned that humidity and salt-spray resistance were usually good. Mr. Fry could confirm this and that it was possible to get very good results on these tests with water-thinned materials. It was surprising how irrelevant the water-soluble groups or water-soluble surface activations were in certain circumstances. It was quite possible to get emulsions and impregnating varnishes which had a performance quite up to the standard of the type of material which was used as the dispersed phase. The author mentioned that the hardness, though adequate, was not so good as that of most conventional primers. It would be of interest if he would say a little more about that, because it had not been his own experience, unless the reference was to specific materials already commercially available. He could see no reason why there should be any lack of hardness simply because the minor modification necessary to make the thing dispersible or soluble were being made.

DR. F. A. CHAMPION (British Aluminium Co. Ltd.) mentioned two points on which he wanted further information. He felt that in the paper

there was not sufficient distinction between air-dried and stoved finishes of this type. He thought that if reliance were placed on dispersion agents or hydrophillic groups, stoving would be important to destroy the properties of those compounds to give an adequate resistance to water ; or, to put it in another way, with a conventional solvent presumably a comparable protection would be obtained by stoving, but with an air-dried finish it might be inferior to the conventional sulphates.

Another difficulty was slow drying which was apparently required to avoid blistering. Were precautions taken within the paint to avoid rusting of steel during that period by the water vehicle? The advantage had been mentioned of not having to dry after wet heat treatment. Was it even necessary to leave an inhibitor to take care of that?

There was one other advantage which had not been mentioned, and that was in confined places. He had in mind particularly long pipe lines in hydraulic systems where it was a difficult problem to get ventilation in working inside the pipe with conventional sulphates. On the other hand, slow drying would be difficult in the short time which was often all that was available.

MR. C. D. S. BRIDGETT (R.E.M.E., War Department) referred to the question of odour and said he had found that many people were allergic to the present household emulsion paints on that account, and unless they were applied in a well-ventilated room people were liable to have a slight attack of what felt like influenza, a " thick head " which lasted for a day or two. It would be a pity if there was the kind of trouble which had arisen with p.t.f.e. some three years ago.

He would like to know whether the different waters had any effect. For example, would Cambridge spring water be better than London water? At what temperature was hot spraying carried out? It could not be very high, or there would be steam coming out. He had tried water thinned emulsions for undersealing on vehicles, but had met with the difficulty of cracking on drying. Had that ever occurred with the author's paint?

MR. D. M. GROVER (Cellon Ltd.) asked whether fresh water was a red herring. It seemed to him that if the steel surface had a fault in it which contained an FeO.OH system the mere presence of a water-reducible coating would create the conditions which would accelerate corrosion. It would mean building up a cell which in a stoving finish was subjected to quite high heat, 300-350°F., and one would have the basic iron system in that cell and the presence of water vapour and the accelerating effect of heat. That could be coupled with the possible presence—and this was where the red herring came in—of chlorides, sulphates and other salts which might be left on the surface due to inefficient washing or washing with rather hard water.

He was trying to relate the possibilities of accelerated corrosion with the comment which had been made earlier that the presence of emulsifying agents and other similar systems seemed to have no effect on the incipient presence of blistering or rate of corrosion or in any way in accelerating corrosion breakdown. It was the presence of inhibitors and the possible inclusion of corrosion pits on the surface which would accelerate corrosion by hydrophillic transfer through the film.

One aspect of the subject which had not so far been mentioned was that of cost. In talking about the reduction by using water-reducible systems they were referring to the apparently low cost of the salt. The basic reactions which were necessary to prepare truly water-dilutable and water-soluble resin systems did not mean that the vehicle itself would be any cheaper than conventional systems, and when dealing with the emulsified types the production procedure and the very high degree of control necessary in manufacturing might keep up the price to something above the equivalent of the other method.

Author's Reply

MR. E. L. FARROW, in reply, welcomed Mr. Fry's agreement that the spraying of these materials had much to do with the dispersion and not the water-soluble types. With regard to the difficulty about the processing of these coatings and the necessity for special conditions, Mr. Farrow had not had a great deal of practical experience on the use of these coatings on a large plant, but from the work done on a certain number of field tests he had the impression that the normal arrangements available in this country would not give 100 per cent satisfactory results ; something would have to be done to modify the equipment so this could be obtained. He was thinking in terms of perhaps having a chamber which had humidifying equipment in it to control the humidity as well.

With regard to the point about the hardness of the coatings, the facts which he had quoted related to the products which he had himself handled. The general feeling had been that the hardness required could be obtained by stoving for a little longer, but for a given time the sulphates appeared to be harder. He did not think that that was an important point.

In reply to Dr. Champion, very little had been said about air drying. Essentially it was related to the stoving process. There were one or two instances where industrial finishing processes were in question and the coating was air dried, but that in his experience was in relation to the use of these materials as casting sealers, and the product could be designed to go on to the surface and not give rusting by virtue of the incorporation of a suitable inhibitor. He agreed that good use for these

PERSONALITIES at the CONFERENCE

Left to right—

Mrs. E. Blewett, Mrs. J. W. Weaver, R. T. F. McManus, D. N. Walker, J. W. Weaver, E. Blewett, A. C. Benning, Mrs. A. C. Benning.

coatings could be found in confined spaces, but the danger would be increasing the humidity to such a degree that the paint coating would not dry off satisfactorily unless the water vapour was carried away and dry air replaced it.

On Mr. Bridgett's point about odour, Mr. Farrow thought that most of the paints which led to objection on ground of odour were those in which there was a high proportion of monomer. At the present time most paint manufacturers had produced products when the residual odour was down to a minimum. What he had been referring to in the paper was essentially the odour of organic sulphates such as butanol.

With regard to hot spraying and the point about the heat involved, a series of tests had been carried out where a temperature of 65-70°C. was found satisfactory and a very good film obtained. A case had been noted where a coating cracked, and he thought that that had been due to bad formulation and could be corrected. This applied particularly to the thicker films. His experience was that with a water-dispersible type of resin there was a tendency to this trouble more than with the water-soluble types, but if the two were intermixed it would do a great deal to overcome it.

Mr. Grover had raised the question of aqueous salts. Generally it was better to use treated water than straight-forward tap water, although tap water had been used in many experiments in this work with very good results. Usually the water-dispersed systems were built to tolerate tap water from various parts of the country and the results had been good. No severe corrosion had been found on properly prepared steel surfaces. On the question of soluble salts being left on the metal prior to painting, this also was something the effect of which had not been seen in the tests which had been carried out. He had no explanation of why there was no trouble, but he knew that the results were good.

On the question of cost two points had been made, that there would be a reduction in cost, and that once these water-thinned systems were used in industrial-finishing paints the overall cost of the finishing would be reduced in that water used for thinning and for cleaning purposes would cost the user next to nothing as against the sulphates which would otherwise be used, which were very expensive.

ABSTRACT NO. 14

THE USE OF VYNYL RESINS IN APPLIANCE FINISHES

by P. R. Day *

VINYL resins, by virtue of their good resistance to heat, chemicals and hydrolysis, are in many ways ideal vehicles for stoving appliance finishes. They have not, until quite recently been widely used for such finishes because of certain disadvantages, notably poor application properties and high cost, which have limited their practical usefulness.

Vinyl resins are prepared by addition polymerization from monomers which contain a double bond in their structure. In the presence of an initiator such as a peroxide, the double bond opens and the other monomer units are added,

* I.C.I. Limited (Paints Division)

in rapid succession, until a polymer is formed. Such polymer molecular chains, being based on carbon-to carbon bonds in the polymer backbone, have a high order of heat resistance to attack by hydrolysis, compared to alkyds and other vehicles based on ester links, especially when the latter are modified with appreciable quantities of oils or fatty acids. The physical properties of films laid down from these polymers can be varied in a number of ways, first, by the choice of monomers used in the polymer, second, by the molecular weight range of the polymer and third, by the method of film formation used.

A large number of vinyl monomers and other materials capable of copolymerizing with them by addition polymerization through double bonds are already commercially available at reasonable cost. A typical selection of the materials of interest in industrial finishes is shown in a Table.

Apart from the choice of monomers to be used the most important feature of a vinyl polymer is its molecular weight. In general it can be said that the physical properties, such as toughness, of an applied film of a vinyl polymer are roughly proportional to the molecular weight of the polymer. The use of high molecular weight polymers leads to application difficulties, while the use of lower molecular weight polymers, which have much better application properties, result in lowering the physical properties of the applied film, and the means of avoiding this difficulty through different mechanism of film formation is fully presented.

In the industrial field, and particularly as appliance finishes, vinyl lacquers have not been accepted, except for those specialized applications where a high order of chemical resistance is required of air-dried coatings. Experimental finishes for washing machines based on commercially available polyvinyl acetate/polyvinyl chloride copolymer resins gave satisfactory performance once they were applied and were in service. They suffered from high cost and poor application properties.

Dispersion finishes, commonly called plastisols or organosols, are one means of avoiding the restrictions placed on the formulator by the necessary compromise between molecular weight, paint solids and application properties of lacquer systems. These finishes are based on vinyl chloride polymers, of high molecular weight, which have been emulsion polymerized in water, and subsequently spray-dried to a powder.
like a pigment using conventional milling techniques, into either plasticizer alone or in a plasticizer/organic solvent mixture.

Another approach to overcoming the difficulties encountered with lacquer systems, and one which also avoids the disadvantages of the dispersion systems, is to use crosslinkable vinyl polymers as the basis for industrial finishes. With crosslinking systems, a relatively low molecular weight polymer containing reactive groups is applied from solution and is then crosslinked by heat, usually with a catalyst, to give a film having all the desired properties of a high-molecular-weight polymer. The stability of these crosslinking systems is discussed and the advantages compared with the dispersion finishes.

The use of crosslinking systems has opened up the whole field of industrial stoving finishes to vinyl resins and a considerable amount of recent work has been directed towards the development of practical finishes. Most of the finishes so far announced by both paint companies and raw material suppliers have been acrylic-based enamels for use on domestic appliances.

This finish was developed as an all-purpose enamel for use on all types of appliances. Its properties include good capacity, extremely high gloss and a slightly mottled appearance similar to vitreous enamel. In addition to white and pastel shades a full range of colours can be made.

In conclusion, the author says that because the many tests have established that appliance finishes based on crosslinking vinyl resins give marked advantages in performance to those based on oil-modified alkyd or epoxy resins blended with nitrogen resins, they have begun to replace these conventional finishes on a number of appliances and are also being used as a replacement for vitreous enamel in certain areas of other appliances.

DISCUSSION

MR. D. H. GROVER (Cellon Ltd.) said that the author had emphasized that when aiming at extremely high performance from any type of system—the example might be quoted of acrylics, which as shown in Table III in the paper had a splendid range—it was necessary to ensure that the basic preparation was adequate to meet the properties wanted in the top coat. The correct choice of pretreatment system in which the properties were brought out to the full seemed essential. The use of a pretreatment system in common use for other systems would not bring out the full properties of the acrylic enamel. A parallel case was found in the comments of Mr. Farrow on plant development, where it was necessary to compromise between the developments in water finishing and the basic production problem of modifying the application conditions and arranging the plant to bring out the best properties of the system which it was intended to employ.

Increase in Viscosity

Reverting to Mr. Day's paper, Mr. Grover appreciated that by using a crosslinked system at normal ambient temperatures there would be some

increase in viscosity. The author said that the enamel had been applied satisfactorily by cold-spraying, hot-spraying, airless-spraying and so on, the reference being presumably to hot and cold airless-spraying techniques. Mr. Grover questioned the necessity to use the two-pack system.

The second factor was solvent resistance. Perhaps the author would give further details about the solvent test used.

What the author said with regard to surface preparation was a splendid challenge to the pretreatment industry, because it was suggested that it might not be possible to maintain the pretreatment at the optimum level suitable for industry.

It was curious that for refrigerator and home laundry equipment lipstick was used for evaluation. That might seem quite unrealistic, but Table III showed that this type of simply applied test gave an extremely accurate evaluation. It was important to control the colour quality of white or blended white enamel, and with the present pace of development it was not always possible to wait for four years to assess the results.

Detergent Resistance

He was very impressed by the author's comments on detergent resistance. It would be interesting to have his views on the level of performance of detergent resistance which could be obtained by using electrodeposited zinc on steel. There was no mention of durability. Mr. Grover thought that acrylic enamels and polyvinyls in general would find an increasing use in industry, and information on the durability of these systems would be welcomed. Had the selection of cross-linking agents any characteristic effect on durability?

Mr. C. D. S. Bridgett (R.E.M.E., War Department), on the subject of surface preparation, agreed with the author that it was very important. The author recommended a light phosphating. Last year Mr. Bridgett had used polyurea paints and obtained far better results with an etch primer than with phosphate. With regard to the stoving of the epoxy paint which the author used for comparison, Mr. Bridgett had been told that the epoxy paints which should be highly stoved broke down if they were under-stoved. They themselves were using a pale cream paint stoved for 1 hr. between 150 and 178°C. and did not get any yellowing.

Authors' Reply

Mr. P. R. Day, in reply, agreed that pretreatment played a very important part. From the point of view of stability, however, he had been dealing with one finish. This one finish was supplied as a two-pack material at the moment for the very simple reason that although when the two components mixed together they showed no viscosity increase for two or three months it was still regarded as safer in the long run to use two packs. That was a commercial rather than a technical decision. From the technical point of view they had had the whole lot in one tin in the laboratory for up to nine months, and some of the alkyds had gelled before this. Possibly he had over-emphasized stability, but it had been one of the difficulties that they had had to face. There were quite a number of very stable systems which could have been discussed; he had simply selected one of them. It was not a fault characteristic of vinyl finishes but applied to the one specific treatment which he had discussed.

The origin of the lipstick test was interesting. In the Canadian company it was done as a matter of form because they had run into difficulty with an odd red discolouration in the upper left hand corner of refrigerators. It appeared on a number of refrigerators and after going through the manufacturer's plant they had eventually found that it occurred with a particular design of door handle and of door, which encouraged the housewife to open and shut the door in a certain way in a number of different houses, and all of them had had sufficient lipstick left on their hands eventually to give a red stain. The trouble was due to the transfer of lipstick, and since then they had always used the lipstick test as one of their standards.

On the question of durability, he would again emphasize that this related to one particular finish. It had not been designed to have superb outdoor durability and if put out of doors there would be an appreciable loss of gloss in from three to six months in Florida and some slight colour change, yellowing, after about six months in Florida. Behind window glass in the normal home and with normal outdoor exposure in English climate it would be quite all right.

With regard to the selection of crosslinkers, it was possible to select crosslinkers, monomers and chemical systems, and to obtain an extremely durable system it would be necessary to look at all three. He could use the same cross linkage and produce a finish which would beat any other vinyl or acrylic finish of which he knew. The panels had had four years out of doors and 24 months in Florida before being withdrawn.

In reply to Mr. Bridgett, etch primers had been tried and he agreed that it was a question of fitting the system to the paint.

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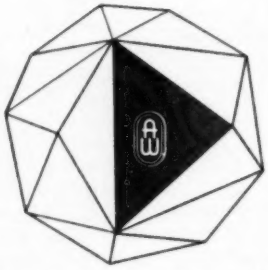

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FINISHING NEWS REVIEW

ANGLO-AMERICAN TRADE RELATIONS

Important Statement by Lord Rootes

WHEN addressing members of the press recently at a conference held at the headquarters of the Federation of British Industries, Lord Rootes spoke of the success at the British Exhibition held in New York for which the attendance figures have been estimated to be far in excess of anything of its kind so far experienced; over 30,000 buyers registered their names and more than 10,000 people made enquiries at the joint stand of the Dollar Exports Council and the Federation of British Industries; in addition, more than 100 genuine enquiries for factory development in this country were received. The success more than compensated for the sceptical lack of enthusiasm that was met from sections of industry when the plans for this exhibition were made initially. Lord Rootes intimated, however, that while the success of the exhibition indicated that we could improve our export trade with the dollar areas, with the liberalization of the dollar trade being brought about by the British Government, it also meant that unless a more determined effort is made to export to the dollar countries and to the world as a whole, our balance of trade may grow gradually worse. Although the exports of the U.K. to the U.S.A. increased by 7.4 per cent for the month, imports to this country from America increased by no less than 95.6 per cent.

Lord Rootes stressed that failure to accept the seriousness of the intense competition from the continent and the U.S.A. is bound to bring about a disastrous situation ultimately.

New Representative Body For Paint Industry

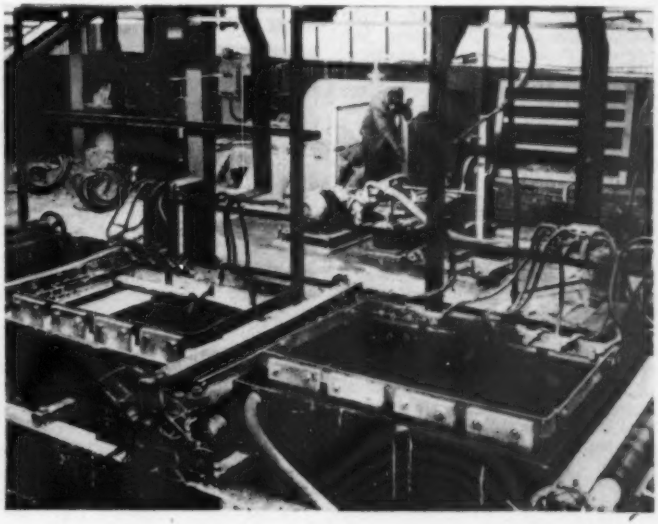
THE Paint Manufacturers' Co-operation Committee, which for a number of years has been the co-ordinating body between the National Paint Federation and the Society of British Paint Manufacturers on matters concerning the external affairs of the industry, has been wound up, and a body has been formed with executive powers to enable action to be taken without reference back to the two trade organizations. The new organization known as the Paint Manufacturers' Joint Executive Council consists of members of both the National Paint Federation and the Society of British Paint Manufacturers; officers are; Mr. E. B. Calvert, past president of the National Paint Federation, chairman; Mr. C. D. O'Sullivan, past president of the Society of British Manufacturers, vice-chairman. Mr. Keith L. Thornbery (Treasurer of the National Paint Federation) vice-chairman; and Mrs. Miriam Bruce (Secretary of the Society of British Paint Manufacturers), secretary.

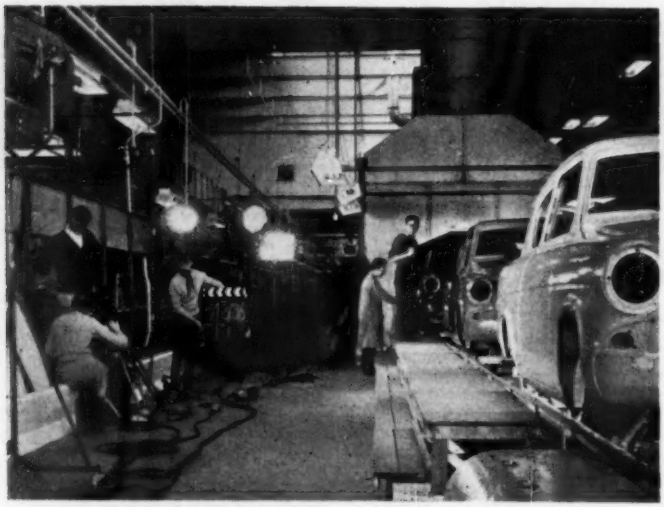
Complete Finishing Systems From One Source

For the first time in the U.K., complete paint-finishing systems, from metal pre-treatment to final stoving, can now be installed by a single organization, the Lysaght-De Vilbiss division of John Lysaght's Bristol Works Ltd.

IN the rolled strip electro-galvanizing plant of the Whitehead Iron and Steel Co. Ltd., Newport, South Wales, a Goodyear A.12 positive displacement rubber-to-metal pump has been installed to circulate the galvanizing electrolyte. The solution, containing a high percentage of corrosive chemicals—including zinc sulphate, aluminium sulphate and sulphuric acid—is circulated at temperatures up to 120°F. through nine tanks used for plating continuous strips of thin mild steel. The plant is capable of plating up to 300,000 sq. ft. of rolled strip per week.

The pump performs this duty 24 hours a day, stopping only when the electrolyte solution is to be renewed or when the anodes are to be replaced in the galvanizing tanks. It is driven by a 5-h.p. Metropolitan Vickers electric motor at 1440 r.p.m. and at less than half the maximum speed, delivers the 4,500 gallons of solution required per hour, replacing two centrifugal pumps which, at their maximum speed, did not deliver the necessary quantity.





PAINTING OF MOTOR CARS IN NEW FILM

A NEW 16-mm. colour documentary film for the motor trade—"Formula for Finish," dealing with vehicle refinishing is in its final stage of production and is expected to be ready at the beginning of September. The film is sponsored by Lewis Berger (Gt. Britain) Ltd. and is being produced by Films of Industry, 115 London Road, Bromley, Kent, the commentator being Raymond Baxter, the director J. S. Roberts and producer John D. Chittock; time 21 minutes. The illustration shows a stoving oven at the Ford Motor Co.'s new paint shop at Dagenham being filmed.

TITANIUM OXIDE PLANT FOR SOUTH AFRICA

CONSTRUCTION work has started on the titanium-oxide plant at Umbogintwini on the Natal Coast, South Africa, by South African Titan Products (Pty.) Ltd., a company formed by British Titan Products Co. Ltd. and African Explosives and Chemical Industries Ltd. The plant is expected to be completed by the beginning of 1962, will have a capacity of 10,000 tons per annum and will cost in the region of £3,000,000.

The contract for detailed design, procurement and construction of the complete factory has been entrusted to W. J. Fraser and Co. Ltd. of Romford, Essex, and of Johannesburg, who will build in accordance with process designs and layouts supplied by South African Titan Products. A pipeline is being laid by Collins Submarine Pipelines Overseas Ltd., along the sea-bed to discharge the factory effluent a mile out to sea at a depth of some 110 feet. This work is being undertaken with the assistance and co-operation of a Steering Committee set up by the Department of Water Affairs of the South African Government.

CHANGES OF NAME

AS from August 2, 1960, C. C. Wakefield and Co. Ltd. have changed their title to Castrol Ltd. This decision has been taken because since the war, their business has grown considerably and the post-war generation attach greater significance to the name of Castrol than to the family name of the producers.

* * *

THE previous name of De-Corrosion (Norwest) Ltd., the recently acquired subsidiary of the Castrol Group has been discontinued in favour of a new title "Metal Cleaning Ltd." who will continue to provide services to clean corroded metals and remove all forms of metal contamination. The techniques used include electro-chemical and chemical immersion and flame and shot blasting. The processes can be carried out on the spot or at the company's Liverpool works at 2-6 St. John's Road, Bootle 20.

THE Magnus Chemical Co. Ltd., Salisbury Road, Uxbridge, Middlesex, point out that their office at 751, Bristol Road South, Northfield, Birmingham, has been set up solely to deal with Midlands business; the company's head office remains at Uxbridge.

SPECIAL CONTAINERS PROTECT FINISH ON WASHING MACHINES

HOOVER washing machine exports to Belgium, which have hitherto been carried in large wooden containers, are now being shipped in containers of similar size, but made of Duramin, supplied and operated by the Van Oppen Shipping Co. These containers take 80 Hoover washing machines or 58 Hoovermatic models and are much lighter and stronger than the wooden containers they supersede, are easier to clean and handle and more attractive in appearance; a considerable saving in shipping costs is also achieved. The illustration shows one of the containers being loaded.

RE-NAMING OF HIGH-NICKEL ALLOYS

HENRY Wiggin and Co. announce new names for certain of their high-nickel alloys. This re-naming has become necessary because of the wide diversity of compositions which have been developed over the last few years to meet specific material requirements.

"Incoloy DS" is the new name for the alloy previously known as "Nimonic DS." This is essentially a nickel-chromium-iron alloy, useful in oxidizing conditions at temperatures up to 950°C. In reducing atmospheres, Incoloy DS may sometimes be used at even higher temperatures. It is particularly resistant to attack from the carbonaceous atmospheres encountered in some types of bright annealing equipment and has good resistance to "green-rot." Originally developed for wire-woven conveyor belts for furnaces. it is increasingly used for furnace parts and a wide range of other high-temperature equipment.

"Valray 1" is the new name for "BAC Brightray," an 80/20 nickel-chromium alloy used extensively for the coating of automobile exhaust valves. Throughout the last war, most aircraft-engine exhaust valves were surfaced with this alloy, which was also widely used in the reclamation of exhaust valves in heavy vehicles. This experience has been extended with the result that, in addition to their continued use for aero-engine exhaust valves, Valray-coated valves are used exclusively by The Rover Co. Ltd. and to an increasing degree by other motor-car manufacturers and fleet owners in the U.K. and overseas. Their use in diesel engines, especially those running on heavy fuels, is increasing rapidly.

"Valray" can be applied either as a protective coating to the valves during manufacture, or it may be used to reclaim valves which have burnt out.

MAJOR COIL-ANNEALING PLANT CONTRACT

THE Incandescent Heat Co. Ltd., Smethwick, has been awarded a major contract for the new Spencer steelworks of Richard Thomas and Baldwins Ltd. at Llanwern, near Newport, Mon. The contract is for coil-annealing plant with an output of 16,500 tons of 60-in. wide strip a week (nearly 100 tons an hour). In all, thirty furnaces will be supplied, of single and four-stack designs, together with furnace bases, forced cooling hoods and other ancillary equipment. The furnaces are the radiant-bowl type, such as have been supplied to leading steelworks in Britain and abroad.

The complete contract, which is worth more than £1¼ million, is believed to be the largest single order for steel annealing plant ever placed in Great Britain. The new steelworks is scheduled to commence operations in October 1961.

Corrosion and Metal Finishing Exhibition

SOME of the country's leading corrosion scientists and engineers will take part in a meeting being held in connexion with the Corrosion and Metal Finishing Exhibition at Olympia this autumn. The Corrosion Group of the Society of Chemical Industry will be holding the meeting on Thursday, December 1, in the Empire Restaurant, Olympia, at the invitation of the organizers of the Exhibition. The papers to be presented will probably deal with the subject of "The influence of water movement on corrosion."

Two of the largest exhibits, will be those of the Atomic Weapons Research Establishment and the Department of Scientific and Industrial Research. Plans are being made for the participation of other Government and professional bodies in the field of corrosion and metal finishing.

Up to the present over 80 firms have booked stands, making an exhibition area on the ground floor of the Empire Hall of over 20,000 sq. ft. Stands on the first floor are now being booked.

The Corrosion and Metal Finishing Exhibition will open at 11 a.m. on Tuesday, November 29 and will remain open until Friday, December 2, 1960.

Full details can be obtained from the Exhibition Director, 9 Eden Street, London, N.W.1.

MULLARD GRANT £25,000 FOR RESEARCH LABORATORY

ONE of the most fundamental and rewarding fields of research in physics at the present time is the behaviour of materials at very low temperatures. Investigations of this kind are an important aspect of the programme of research at the Clarendon Laboratory of Oxford University, where Professor B. Bleaney, F.R.S., is Dr. Lee's Professor of Experimental Philosophy.

A sphere of especial importance is the variation in the magnetic properties of materials at near the absolute zero of temperature and Dr. Nicholas Kurti, F.R.S., of the Clarendon Laboratory, is particularly concerned with investigations of this nature.

To extend the University's efforts in this direction a new laboratory is to be built for the purpose and Mullard Ltd. have made a grant of £25,000 towards the cost of this new building.

The new laboratory will be known as the Mullard Cryomagnetics Laboratory.

Recently Dr. Kurti's work in low temperature research was the subject of a B.B.C. "Eye on Research" programme in the special series commemorating the tercentenary of the Royal Society.

Joint Symposium "Protection of Gas Plant"

THE Institution of Gas Engineers and the Society of Chemical Industry are holding a joint symposium on the "Protection of Gas Plant and Equipment from Corrosion," at the College of Advanced Technology, Birmingham, from September 22 to 23, 1960. Participation is open to all and charges for registration are £2/2/- to members of the Institution and the Society and bona-fide students of universities and technical colleges and £3/3/- to others.

ELECTRICAL FAIR CANCELLED

THE First Electrical Fair which was scheduled to be held at Alexandra Palace from September 23, to October 1, 1960, has been deferred, the majority of exhibitors having indicated that they prefer a venue in Central London. The organizers hope to make a further announcement in the near future.

CHANGE OF TEL. NO.

THE new telephone number of Trico-Folberth Ltd., Great West Road, Brentford, Middlesex, is Isleworth 8937-8.

Commander Geoffrey Clarke

Don Schreckengost

INDUSTRIAL FINISHES EXHIBITION

Earls Court, May 8 to 11, 1961

THE growing importance of new techniques and improved technologies in the field of industrial finishes with their almost universal relevance to the problems of international industry, makes it particularly appropriate that the First International Industrial Finishes Exhibition is to be held at Earls Court, London, from May 8th to 11th, 1961.

The exhibition will feature equipment, materials, plant and processes used in the industrial finishing field, and exhibits will incorporate metal pre-treatments, paints and their applications, electroplating, galvanizing, metal colouring, anodizing, plastic covering, vitreous enamelling, shot-blasting, vacuum deposition, instrumentation and all the necessary ancillary equipment for the finishing of industrial products.

The exhibition is being organized by the Exhibition Division of Scientific Surveys, Ltd., 97, Old Brompton Road, S.W.7 (telephone: Knightsbridge 9360) from whom all details can be obtained.

TECHNICAL *and* INDUSTRIAL APPOINTMENTS

Commander Geoffrey Clarke has joined the **Vitreous Enamel Development Council** as its new general manager in succession to Mr. Ken Jones, who is assuming an industrial appointment in Africa. For the past two years Commander Clarke has been assistant to the director of the British Productivity Council and prior to that served in the Royal Navy, which he joined at the outbreak of war as a rating.

* * *

Styrene Co-Polymers Ltd. have appointed Mr. K. E. Piggott, chief chemist, to the post of technical manager and Mr. P. G. Salmon to marketing manager.

* * *

The O. Hommel Co., Pittsburgh ceramic colour suppliers, have acquired the services of Don Schreckengost, well known designer and colour authority, to help carry out the company's intention to support and develop new uses for ceramic colours. Don Schreckengost has had considerable experience in the colour and design field and during a varied career has received numerous awards in the fine art and industrial consumer product fields; for some time he was Professor of Industrial Ceramic design at New York State College of Ceramics, Alfred University, and is currently a Fellow of The American Ceramic Society, vice-chairman of the design division, and a member of the Inter-Society Colour Council and Industrial Designers' Institute.

* * *

Mr. P. H. Cripps has been appointed the regional sales manager for London and the Home Counties of the industrial division of **Wakefield-Dick Industrial Oils Ltd.,** a member of Castrol Group of companies.

* * *

Mr. Ernest Coverdale, chairman and joint managing director of **Permoglaze Holdings Ltd.,** and Mr. Peter Coverdale, joint managing director, have joined the board of **Blundell, Spence and Co. Ltd.**

At the same time, Mr. E. B. Calvert, chairman and managing director of Blundell, Spence and Co. Ltd., and Mr. A. F. Bacon, executive director, have been appointed directors of Permoglaze Holdings Ltd. and Permoglaze Ltd.

These appointments are made following the announcement that an agreement had been reached for a merger to take place between the two companies.

* * *

Griffiths Bros. and Co. London Ltd., paint and insulating varnish manufacturers of Wednesfield, Staffordshire, have appointed three new representatives; Mr. J. Hopkins is to cover the South Wales area, Mr. R. W. Birkenshaw the West Midlands and Mr. F. Grandidge the Manchester and North West area.

* * *

The Mond Nickel Co. Ltd. and its subsidiary company, **Henry Wiggin and Co. Ltd.** have made the following changes as from July 1: Mr. G. Archer relinquishes his position as chairman of both companies and is appointed president, Mr. Ivon A. Bailey is appointed chairman and chief officer of Mond and Wiggin, Dr. L. B. Pfeil is appointed vice-chairman of Mond, Mr. J. O. Hitchcock managing director of Mond and deputy chairman of Wiggin, and Mr. H. W. G. Hignett managing director of Wiggin.

* * *

Honeywell Controls Ltd. have appointed Mr. A. Stephens as senior flow engineer at the company's Greenford (Middlesex) head office and Mr. R. W. H. Vivian has been appointed to specialize on application engineering using the company's electric miniature instrumentation, which is being introduced in the United Kingdom this year.

CHANGE OF ADDRESS

AS the growing scale of their business now requires larger premises, Pinchin Johnson and Co. have transferred their Birmingham office and depot to 18/22, Rotton Park Street, Birmingham 16 (tel.: Edgbaston 5151). The Midland Manager of the company is Mr. H. V. Mahoney.

American Cut-off Machines to be Produced in U.K.

B.O. MORRIS Ltd. of Morrisflex Works, Briton Road, Coventry, have formed a Wallace Division at their Coventry factory to produce cut-off machines under licence from Wallace Supplies Manufacturing Co., Chicago, U.S.A., which they claim offer burr-free cutting.

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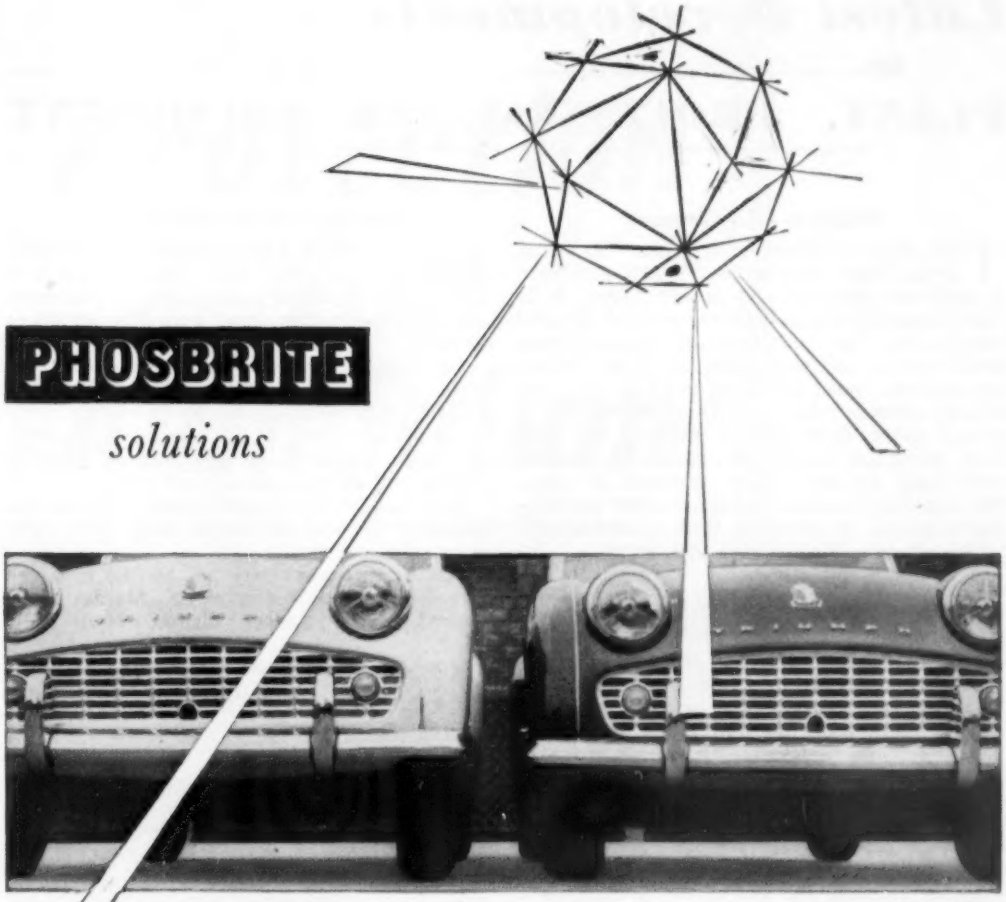

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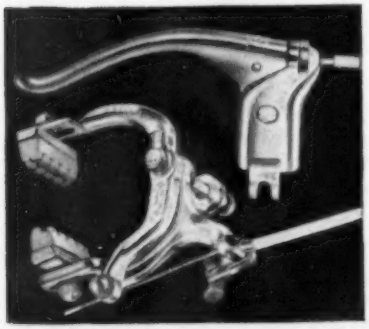

Whether it is car trim (like the Triumph T.R. 3 grille above) or cycle brakes (like the G.B. Cycle Components Ltd. product on the left) you will find that chemical polishing with Phosbrite solutions saves time and money.

There are Phosbrite solutions for chemically polishing aluminium and copper and their alloys and for electrolytic polishing of alloy and stainless steels.

Albright & Wilson (Mfg.) Ltd. also supply Plusbrite addition agents for bright nickel plating, together with chemicals for special processes in tin, copper and nickel plating and electrolytic polishing of ferrous metals.

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TMW/631

Latest Developments in PLANT, PROCESSES AND EQUIPMENT

Inhibited Acid Cleaner

THE Magnus Chemical Co. Ltd., 751 Bristol Road, South Birmingham, 31, have developed a powdered, inhibited acid cleaner, (Super Scale Solv.) especially designed for the removal of hard-water scale, rust and corrosion products from metal surfaces and particularly useful for boilers, economizers, water circulating systems, etc. The cleaner contains inhibitors and wetting agents to protect sound metal surfaces while at the same time promoting rapid penetration and reaction with scale deposits. When dissolved in water the ingredients become chemically active attacking rust and scale by converting them to soluble salts which are easily flushed away with water.

Liquid Plastic Spray Coating

THE Industrial Finishes Division of Jenson and Nicholson Ltd., of Stratford, London, E.15., have developed the plastic coating, originally produced for cocooning war materials, as an industrial finish under the trade name of "Liquid Envelope." Its application is simple since it requires no reducing agent and can be sprayed just as it is received after rapid mechanical agitation to bring it to the consistency of cream ; it does, however, need higher pressures and heavier-duty spray equipment than are used for paint spraying. Among the uses of the preparation is the protection of enamelled ware both in transportation as well as after fixture, industrial packaging and storage, and also as a lasting protection for roofs and sidewalls.

Cold Abrasive Cement

W. CANNING and Co. Ltd., of Great Hampton Street, Birmingham 18, have produced cold cement for bonding abrasive powder to polishing mops and bobs, resulting in the production of a fine finish on metals in a remarkably short time and prolonging the life of the abrasive head.

The method of application is to brush "Nupol" Abrasive Cement No. 3205 to the mop surface and the edges, roll the mop in "Nupol" Powder No. 1 and then stove for about 4 hours. During use the mop surface is lubricated with "Carbrax" composition, medium greasy and G.W. bobbing grease applied alternately.

Industrial Pocket Microscope

FIG. 1 illustrates a high powered pocket microscope which the Ellis Optical Co., have designed and produced with optically worked lenses and has a magnifying power from 20 times up to 40 times.

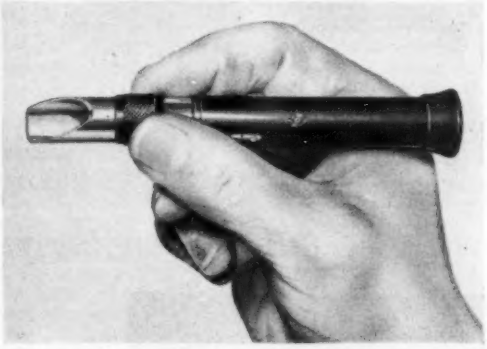
An advantage is the mirror at the base which when turned towards a light source reflects light on to the object to be examined.

Magnification can be increased by extending the sliding tube and correct focusing is easily obtained by adjusting the knurled ring.

The circle of field is approximately $\frac{1}{2}$ in. and the microscope is easy to handle being little more in size than the average pen.

Further particulars may be obtained from the manufacturers : Ellis Optical Co., Mayday Road, Thornton Heath, Surrey. Thornton Heath 3601.

Fig. 1—Pocket Microscope



Mineral-Insulated Thermocouple Materials

ACCURACIES of 3 per cent below 400°C. and $\frac{3}{4}$ per cent above 400°C. are claimed from the first of mineral insulated thermocouple materials available from Honeywell Controls Ltd. Accuracies up to 3 times as good are available to special order.

Supplied separately or made up into thermocouples, the new material is suitable for use throughout the industry, though not in the nuclear field. Initially there are 2 materials, Chromel/Alumel (Hoskins Company manufacture) and T1/T2, the

(*Continued in page* 340)

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wire sizes being 0.020 in. and 0.010 in. respectively, and overall sheath diameter 0.122 in. and 0.060 in.

Resistance per foot for the Chromel/Alumel is 1.1 ohms (positive conductor) and 0.44 ohms (negative); resistance per foot for the T1/T2 is 4.6 ohms (positive) and 1.85 ohms (negative). Insulation resistance is 100 megohms minimum.

The material can be supplied with ends sealed and no junction made, as thermocouples having one hot junction, with or without mounting attachment. A thread is supplied as standard at the cold end.

The two materials are the first of several mineral insulated materials being introduced during 1960 by Honeywell Controls Ltd., Greenford, Middlesex.

Cadmium Plating

THE Hanson-Van Winkle-Munning Co. of Church Street, Matawan, New Jersey, have introduced a simple-to-operate low-cost process for bright cadmium plating, "Cadalume L" for the protection of iron and steel parts against corrosion and non-ferrous metals subject to surface tarnish and corrosion or those which form undesirable galvanic couples in dissimilar metal assemblies. The process is claimed to have the following characteristics: increased plating speeds, improved deposit distribution and throwing power, heavier deposits without loss of brilliance or tendency to form nodules or trees, stable brighteners with no salting-out effect, no tendency to induce pitted deposits, wide bright range.

Non-destructive Testing Equipment

THE Introview flaw and corrosion detector illustrated in Fig. 2 was shown for the first time at the I.E.A. Exhibition by the manufacturers Sperry Gyroscope Co. Ltd., Great West Road, Brentford, Middlesex. Up to now the detector has been used for the testing of non-ferrous material in tubular, strip or rod form, but recent developments have made it possible to use it on non-magnetic stainless steel.

The instrument makes use of the eddy currents set up in the material under test induced by an a.c. excited coil placed in close proximity to the material; these eddy currents modify the apparent impedance of the coil in proportion to the conductivity of the path created by the surrounding material; any variation in this conductivity causes a proportional variation in the apparent impedance of the coil, unbalances a bridge network and the magnitude and phase is recorded on a chart, thereby enabling flaws to be identified.

The equipment consists of a recorder unit, power pack, probe, probe injector and probe winch unit. In the illustration the equipment is being used inside the condenser box of a destroyer to test a condenser tube, the method being to propel a probe together with a flexible cable attaching it to the winch unit, to the far end of the tube by compressed air—the probe is then drawn back through the tube and a recording made of the state of the condenser tube on the recorder unit.

Fig. 2—Flaw and corrosion detector

Acrylic Stoving Enamels

CELLON Ltd., of Kingston-on-Thames have produced a range of stoving enamels based on acrylic resins and known as Cerrux "76" Line, which are claimed to embody outstanding surface hardness and gloss with excellent colour, colour retention, resistance to heat, detergents, stains, etc. Three types are offered — a general purpose finish, a formulation embodying maximum flexibility and one embodying maximum resistance; they are suitable for use as one coat or two coat systems and have excellent spraying properties by both hand and electrostatic methods. Because of their quick "set" they have good build and collect less dust; wet on wet systems under normal production conditions give an average film thickness of 1½ thou. with good opacity. Heat stability gives good resistance to over-stoving and the intercoat adhesion is very satisfactory.

(*Continued in advt. page* 28

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Plant, Processes and Equipment

(*Continued from page* 340)

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A BENCH model, all-purpose, muffle furnace has been designed by the Allied Engineering Division of Ferro Enamels Ltd., of Wombourn, Wolverhampton, to meet the demand of industry for a neat, compact and reliable unit for temperature's up to 1000°C. The working chamber consists of a nichrome wound muffle forming an independent unit readily interchangeable with the minimum of effort.

The muffle size which has proved to be most practicable for test firing samples is 18-in. deep by 5¼ in. high by 7½ in. wide. An adequate quantity of insulation surrounds the muffle to ensure low heat dissipation to the outside casing. The casing is of all welded, sheet-metal construction with the exception of the top section whereby access is obtained to the muffle. A guillotine-type door operating on a chain and pinion mechanism and counter balanced for ease of movement forms an effective heat seal to the muffle opening. Control is effected by an infinitely variable energy regulator operating through a contactor relay. The furnace is also available with fully automatic control.

Signal lights are provided in the circuit indicating electric supply to the kiln and position of contactor. A safety switch in the circuit also breaks the supply when the door is opened. The furnace operates off standard single-phase electricity supplies, is normally rated at 2.75 at 230 volts and reaches 800°C. in two hours. Temperature uniformity is within 5° from the front to the rear of the muffle and due to the degree of insulation, which is twice that of other commercially available models, temperatures are extremely stable in operation.

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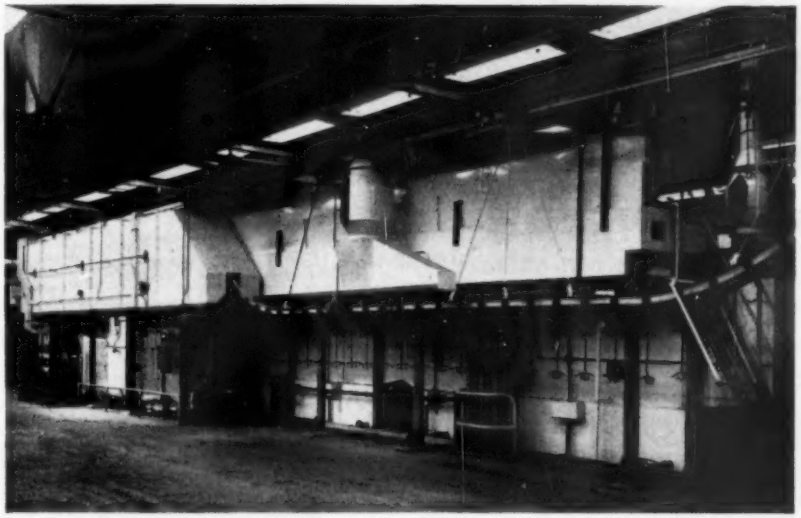

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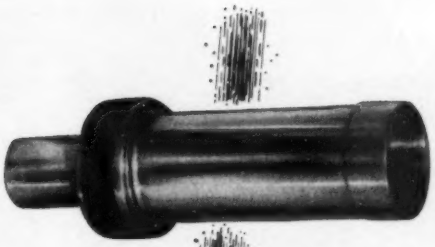

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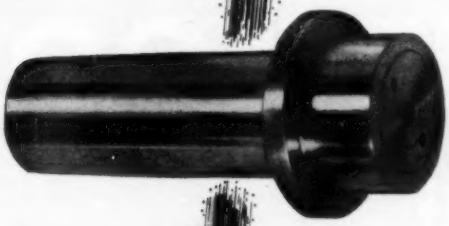

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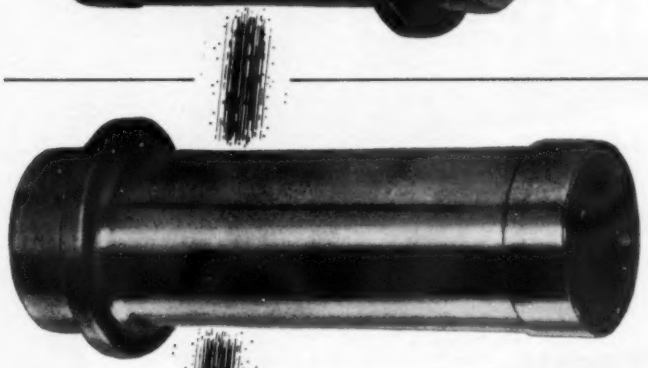

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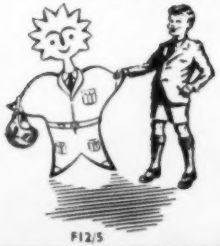

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